Gas Journal

VOL. 292. 109th YEAR. LONDON, NOVEMBER 13, 1957 No. 4922 PRICE 1/6

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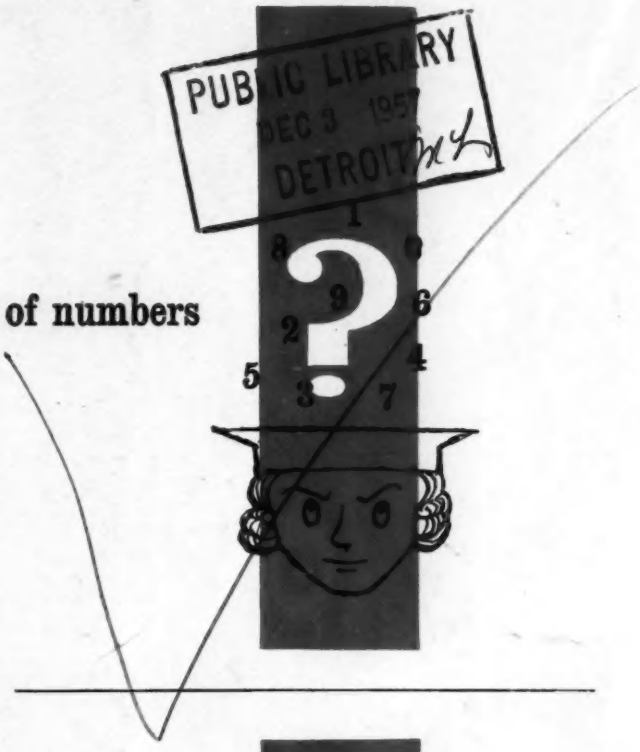
DETROIT

When it's a question of numbers

It's neither too large nor too small — it's compact enough to fit into the crowded kitchen of a small hotel, cafe or restaurant, yet it has the capacity to meet a fluctuating demand handsomely. It's ready and able — being specially constructed — to make light of hard work. The 'Potterton' Catering Cooker, being precisely the size that it is, fills a very specific catering need.



'Potterton' Catering Cooker comes to mind

The 'Potterton' Catering Cooker has six boiling burners, three of them with double rings. Four models are available, the Standard model with a plain splashback, the Standard model with a plate-rack or with twin eye-level grills or the model with twin grills and with plate-rack. List prices from £66.

POTTERTON DIVISION, Thomas De La Rue & Co. Ltd. 20/30, Buckhold Road, London S.W.18.

DL795

METAL DETECTION

The 'Cintel' Portable Metal Detector is the quickest and most economical method of locating hidden manhole covers, buried pipes, etc. If you are one of the few not yet using this instrument, may we send you details?

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CINEMA-TELEVISION Ltd.

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SALES AND SERVICING AGENTS — *Hownt & Co. Ltd. 59 Moor St., Birmingham, 4.* · *Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow* · *McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester 16.*

THE Linton HIGH PRESSURE GAS SERVICE REGULATOR

This regulator is of a new design developed for mass production by modern methods, which allow seven main types of regulators to be produced, covering a very wide range of individual requirements, but utilising generally the same main components.

The regulator is suitable for controlling the gas supply to domestic premises from high pressure mains, or low to medium or high pressure mains.

FULL DETAILS ARE GIVEN IN OUR PUBLICATION G/81.

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LINCOLN WORKS — CHESTERFIELD. 3, VICTORIA ST. WESTMINSTER S.W.1

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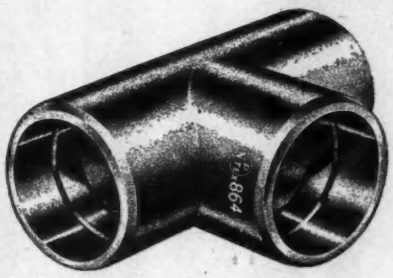
I.C.I tubes

Copper Tubes from Kirkby
to BS 659 and BS 1386 for gas, water and waste services. Tubes for radiant panel heating, locomotive and ship services, refrigerators, chemical and general engineering.



'INTEX P.T.'

& fittings

Tube Fittings from Fyffe's to BS 864
'INSTANTOR'
'KUTERLITE'
'INTEX P.T.'
Easy
Quick
Reliable

ICI METALS DIVISION

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1.

M.452A

Peebles & CO. LTD.

From one set of tools the domestic pattern:-

FIG. 153 **GOVERNORS**

FIG. 154 **CUT-OFF VALVE WITH PUSH BUTTON CONTROLLED WEEP RESETTING**

FIG. 155 **COMBINED GOVERNOR AND CUT-OFF VALVE**

NEAT · CHEAP · EFFICIENT

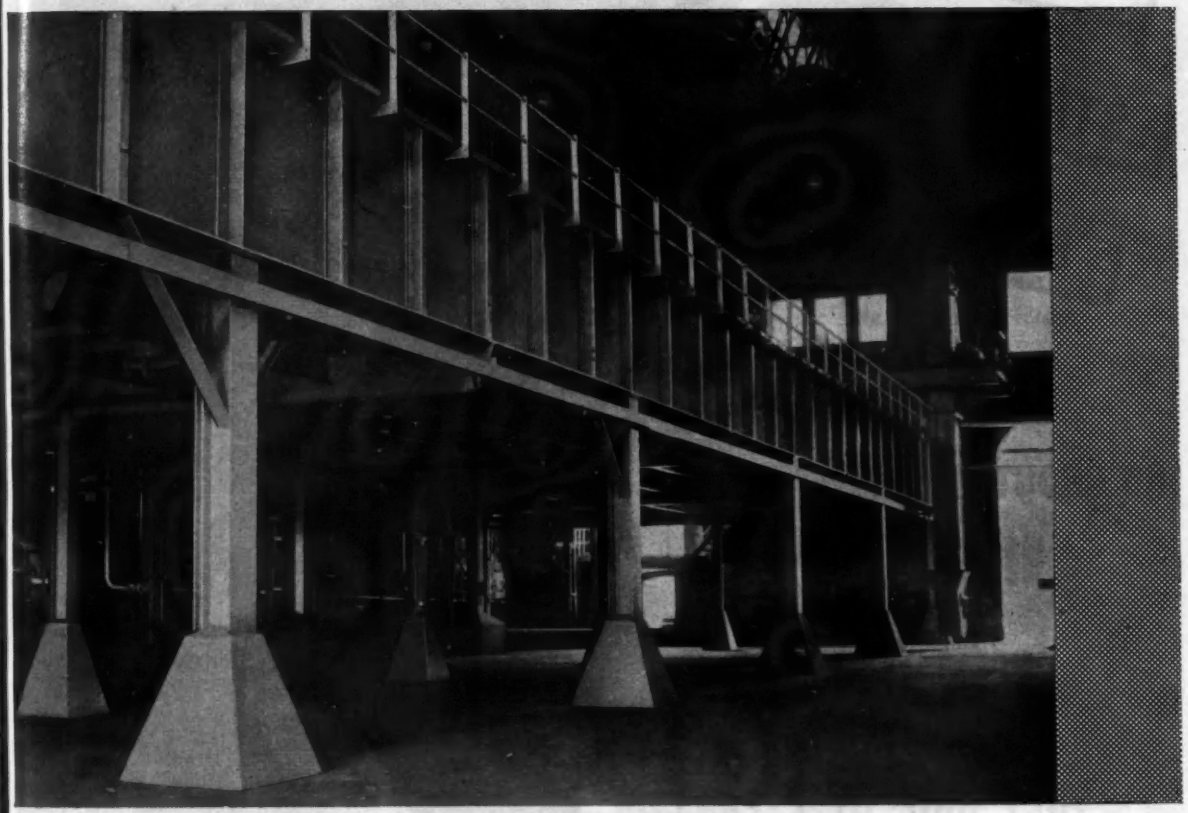
Further Details on application.

TAY WORKS · WEST BOWLING GREEN STREET · EDINBURGH 6

Telephone No.: LEITH 36544 & 35069 **Telegrams: TANGENT EDINBURGH**

WHESSOE

PURIFIERS AT JERSEY



This set of five welded mild steel overhead purifier boxes were built by Whessoe for the Jersey Gas Light Co. Ltd.
The plant which was installed in a former retort-house, has a capacity of 3 million cubic feet per day.
The boxes each contain two 2′ 6″ deep layers of oxide.
Special attention was given to the structural design of the plant to provide easy and unobstructed access with ample headroom to the bottom discharge chutes and oxide elevator within the confines of the building. The photograph shows the resulting clean design and illustrates the advantages of welded construction.

WHESSOE LIMITED, Darlington, Co. Durham Telephone: Darlington 5315
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W96/CIRWR

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SAVE TIME with Rawlbolts. Grouted ragbolts will take 3 days to harden before the machine can be used. Use Rawlbolts and the machine can be in production in much less than 3 hours. It can be moved easily to a new position when necessary.

SAVE LABOUR with Rawlbolts. No laborious and time wasting cold chiselling with Rawlbolts. The holes are drilled with a Rawltool to the exact size, the Rawlbolts dropped in and after the machine has been positioned the bolts are tightened. The expansion of the segments locks the bolts in the holes.

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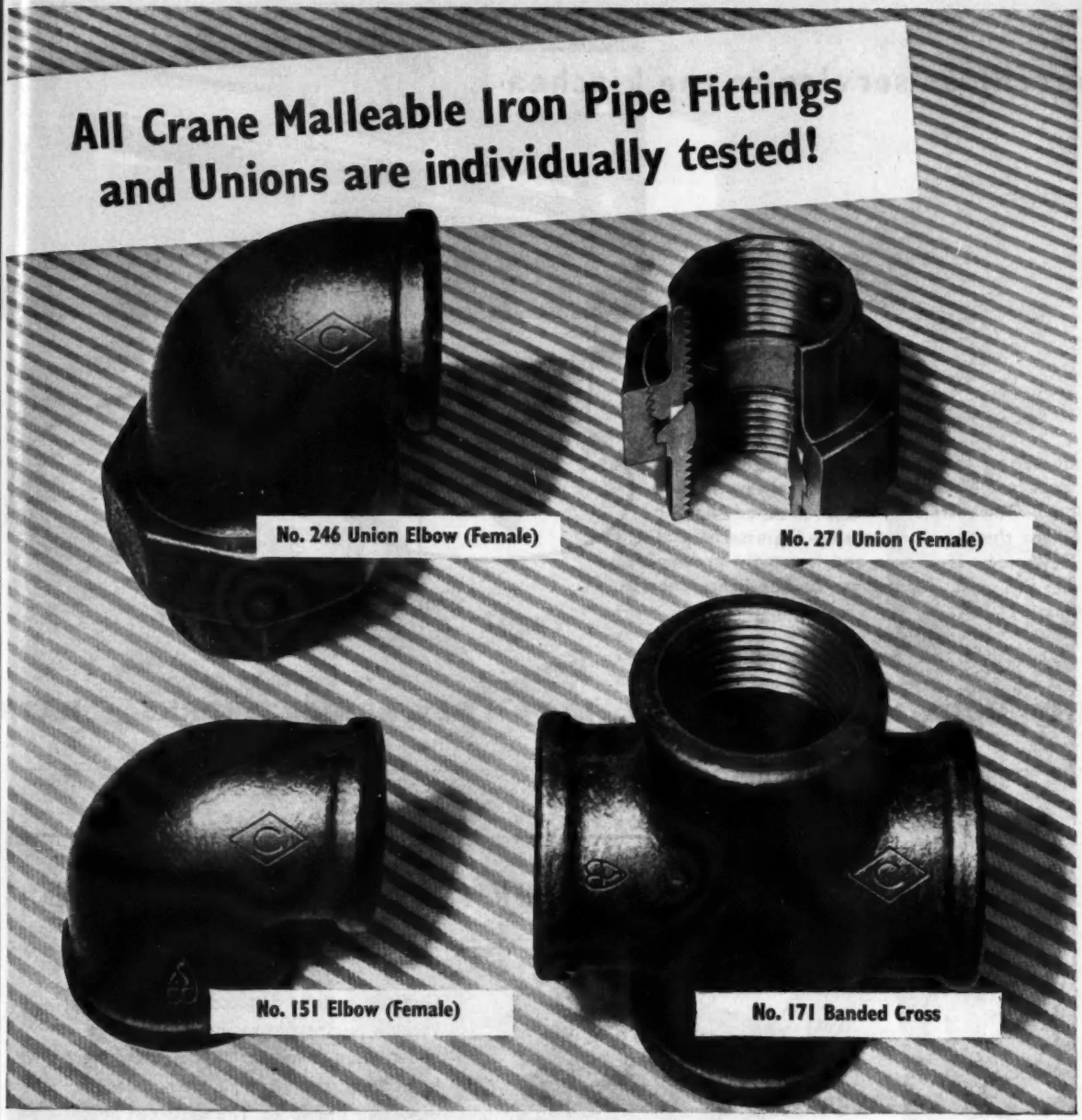
The world's largest manufacturers of fixing devices

***Write now** for illustrated literature giving full details of Rawlbolts and the many high performance Rawlplug tools (hand, electric and pneumatic.)*

THE RAWLPLUG CO. LTD · CROMWELL ROAD · LONDON S.W.7

All Crane Malleable Iron Pipe Fittings and Unions are individually tested!



B4

The searching tests given to every individual fitting and union at the Crane factory ensure the consistent high quality of these well-known products. Their good appearance, clean finish and dependability have long earned them the confidence of the most exacting buyers.

Plain and Banded Pattern Fittings

All Crane Malleable Iron Pipe Fittings have taper threads and are manufactured to British Standard No. 143. They are available in plain and banded patterns with either black or galvanized finishes. Sizes (equal and reducing) ⅛″ to 6″.

All Iron, Railroad, Navy Pattern and Flat-face Unions

There are four types: Iron to Iron; Bronze to Iron (Railroad) and Bronze to Bronze (Navy)—all with spherical seats; and Flat-face gasket type. All have British Standard taper threads. Sizes ⅛″ to 4″. *Write for full details.*

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Branches: Birmingham, Brentford, Bristol, Glasgow, London, Manchester

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Mk. III
GAS PISTOL

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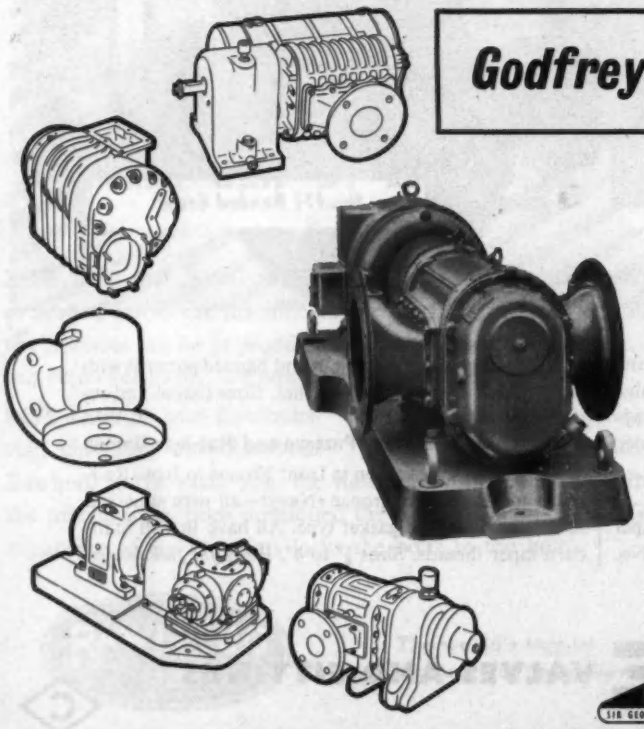
For further details write to:

THE HORSTMANN GEAR CO. LTD · NEWBRIDGE WORKS · BATH



Godfrey Industrial Equipment

Godfrey positive displacement blowers, vacuum pumps and gas boosters are widely used in industrial processes where large flows of oil-free air are required at moderate pressures. The units can be supplied complete with motors on baseplates. Performance: Flows up to 3,500 c.f.m. at pressures up to 10 p.s.i. Also available: superchargers, diaphragm pumps, relief valves, etc.

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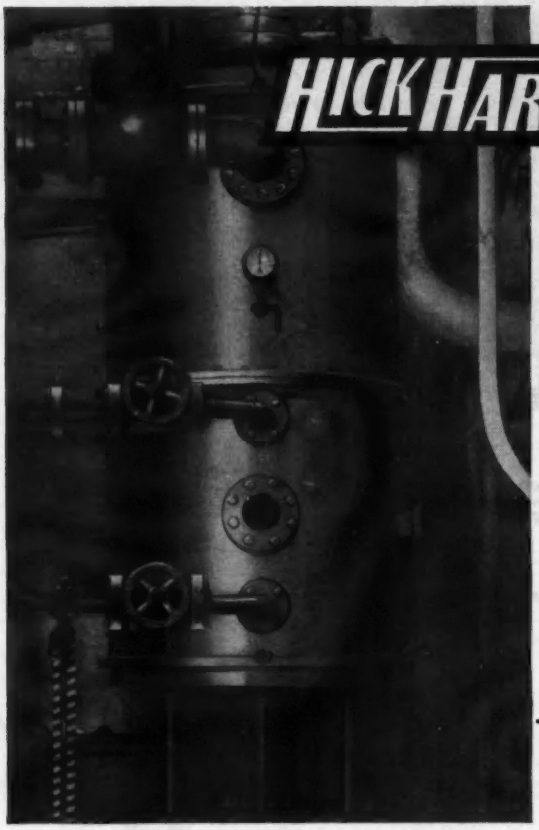

HICK HARGREAVES FEED WATER DEAERATORS

The most efficient—and simplest—means of reducing the oxygen content of feed water is to install a Hick Hargreaves patented Recirculating De-aerator. Having no floats or spray valves this de-aerator is exceedingly reliable in use and is able to provide effective de-aeration under all conditions of flow, being able to cope efficiently with the widest and most rapid variations in the feed rate.

Available in two types—

1. Straight spray for feed temperatures above 130°F. (55°C.)
2. Direct contact heater De-aerator with patent atomising jet system, for feed temperatures below 130°F. (55°C.)

The illustration shows a Hick Hargreaves De-aerator size 40D at the Margam Works of the Steel Company of Wales Ltd. Consulting Engineers : Messrs. McLellan & Partners

H127A

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MULTI-CELL CENTRIFUGAL PUMPS

FOR

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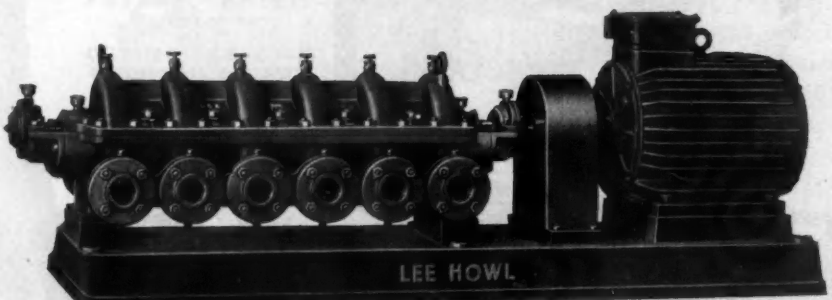
FOR THE EXTRACTION OF BENZOLE, NAPHTHALENE and AMMONIA



PHOTOGRAPH SHOWS A 2" SIZE SIX CELL PUMP WITH CIRCULAR FLANGES

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Completed in 1956
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Birmingham

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- Condensing Plant
- Tar Extractors
- Washers (Pumpless Patent)
- Oxide Purification Plant
- Patent Boxless Purifiers
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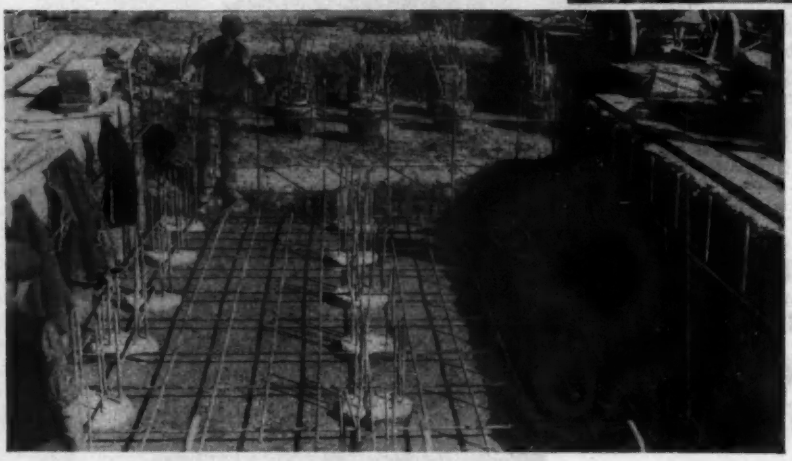
BORED PILES FOR THE N.F.U. KNIGHTSBRIDGE SITE



The heavy foundation loading from this building made normal footings for the columns out of the question —a condition frequently obtaining to-day when higher storeys are permitted. Piling was necessary and the close proximity of other buildings, including a Hospital, precluded the use of heavy driving equipment with its accompanying noise and vibration.

Cementation Bored Piles were selected by competitive tender and the foundation work was completed very successfully notwithstanding the difficult ground conditions unexpectedly encountered.

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. . . "and an insulating course of Fosalsil between the refractory lining and the steel casing"

When specifying large quantities of insulating bricks, you can confidently rely on the Moler Products range. Made under controlled conditions in the largest and most modern plant in Great Britain devoted to the manufacture of insulating materials. Fosalsil Solid Grade and Economite diatomaceous earth type insulating bricks and M.P. insulating refractory bricks are in large scale production. The range is now made fully comprehensive by the introduction of Fosalsil Lightweight Slab insulation—a new material with exceptional insulating efficiency, designed for easy installation over large wall surfaces protected by steel plating. It will withstand temperatures up to 1,700°F., and is available in various thicknesses from 1" to 3" max. overall dimensions 36" × 12" or 24" × 18". *Full technical details on request.*

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PATENT NO. 733220

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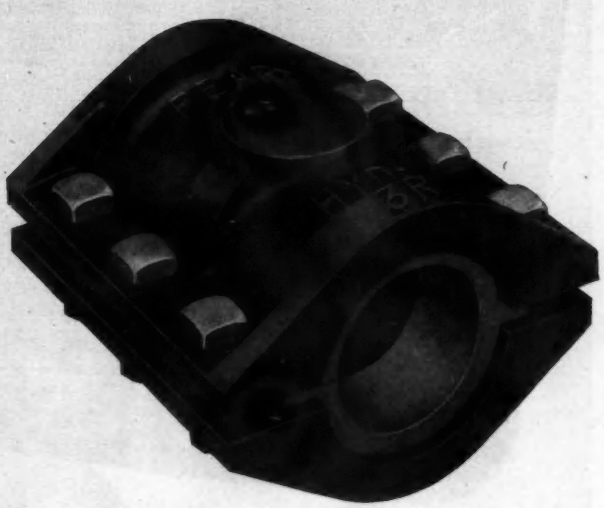
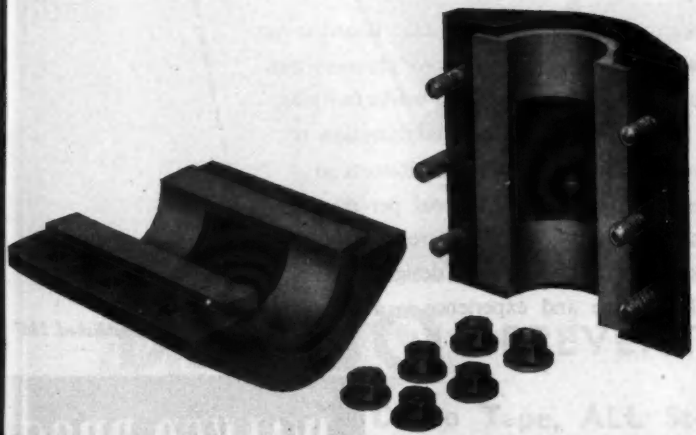
★ GUARANTEED SEAL WITHOUT USING LEAD

★ EASILY TRANSPORTED.

★ ONE SPANNER ONLY REQUIRED.

★ CAN BE FITTED IN TEN MINUTES.





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★ DRILLED AND TAPPED ¼"-2" B.S.P. IF REQUIRED.

★ TESTED UP TO 350 lbs. p.s.i. HYDRAULIC PRESSURE.

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Photograph by Courtesy of the South Eastern Gas Board, Dover and Woodall-Duckham Construction Company Ltd.

Development at the Dover Works of the South Eastern Gas Board is yet another fine example of co-operation between experienced planners and engineers, and the resources of an organisation with exceptional works facilities. The supply of structural steelwork has been Walker Bros. contribution to the new Woodall-Duckham Installation of Continuous Vertical Retorts at Dover. These retorts are capable of carbonising 821 tons of coal per day, thereby producing some 13 million cubic feet of gas. We are highly organised to tackle any structural steelwork problem, from design to erection and ninety years of specialist knowledge and experience is at your disposal.

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A Service Engineer would gladly co-operate

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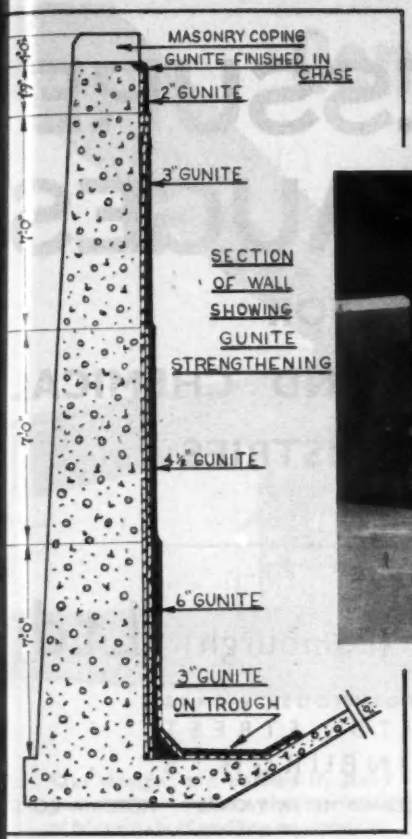
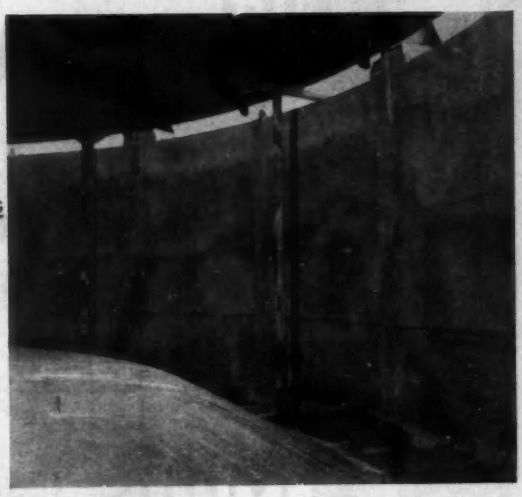


GUNITE Repairs To Gasholder Structures



This 50 year old gasholder tank at Pontefract Gas Works is 92' 6" in diameter and 23' 9" deep. The foundations had failed and the tank was severely cracked and losing over 23,000 gallons per day. We lined the walls with gunite reinforced to take the full ring tension, and carried out extensive pressure grouting of the underlying rock to stabilise the foundations.

Employing Authority :—
North Eastern Gas Board, Wakefield Group.

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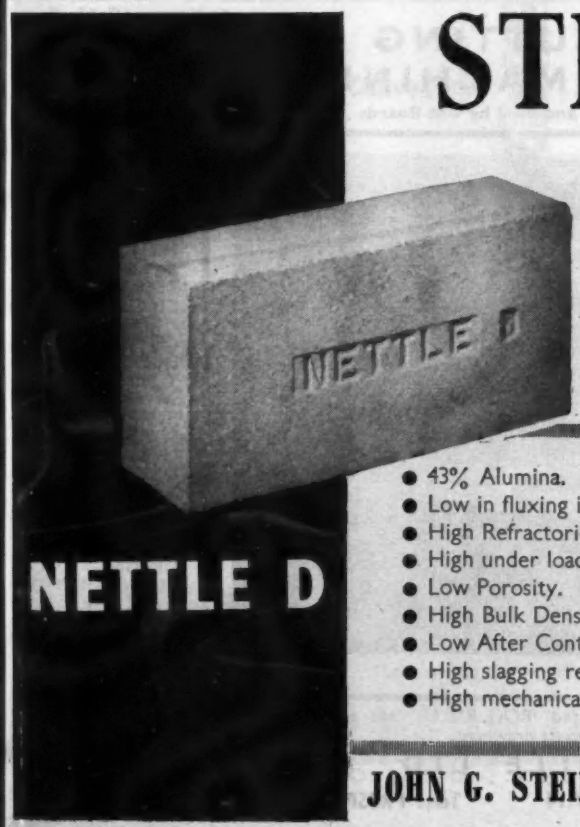

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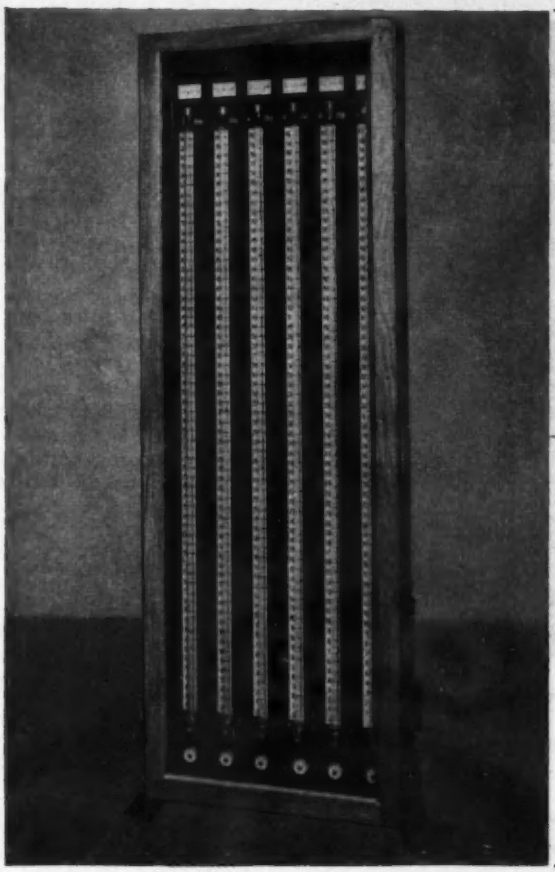

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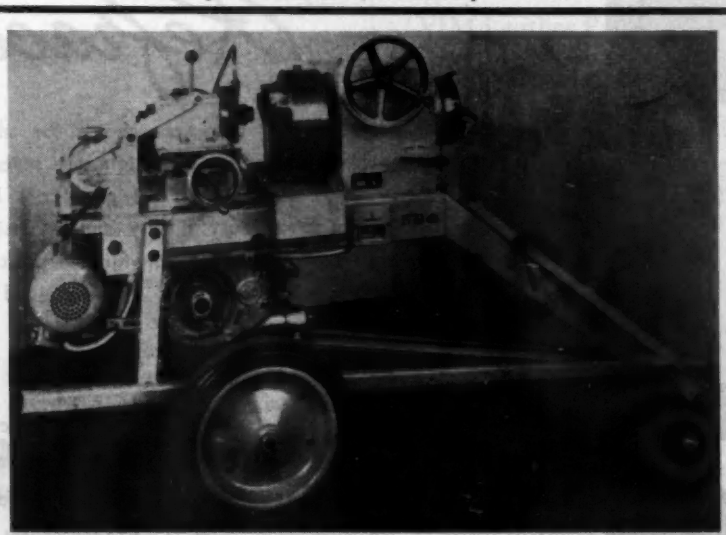
For B.S.P., CONDUIT, AMERICAN (API), WHITWORTH & UNIFIED SCREW THREADS

PRODUCES NIPPLES FROM SCRAP

BEVELS TUBE FOR WELDING



DUAL DRIVE (PETROL/ELECTRIC) TROLLEY MODEL

THE "RG" MACHINE PRODUCES THREADS BY MEANS OF THE MILLING PRINCIPLE—NO DIES REQUIRED. A CIRCULAR SAW FITTED TO THE CUTTING SPINDLE ENABLES TUBING TO BE SAWN, FREE OF BURR, TO ANY REQUIRED LENGTH WITHOUT REMOVAL FROM THE MACHINE. THE "RG" IS STURDILY BUILT & DESIGNED TO BE OPERATED BY UNSKILLED LABOUR. IT REQUIRES THE MINIMUM OF MAINTENANCE

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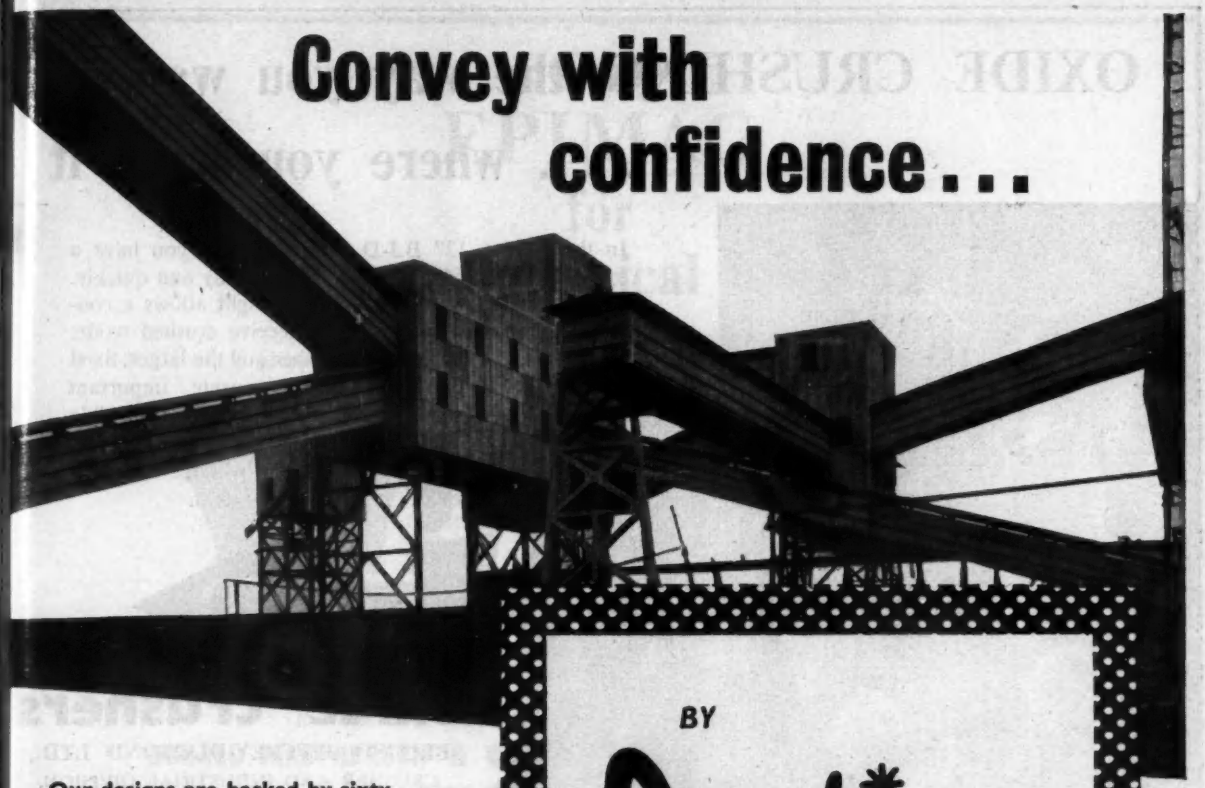

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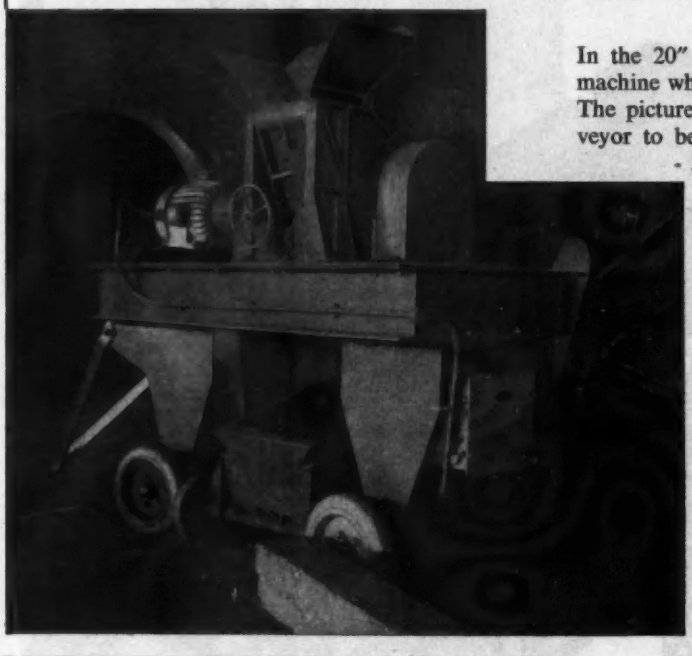
B

OXIDE CRUSHING the way you want it . . . where you want it

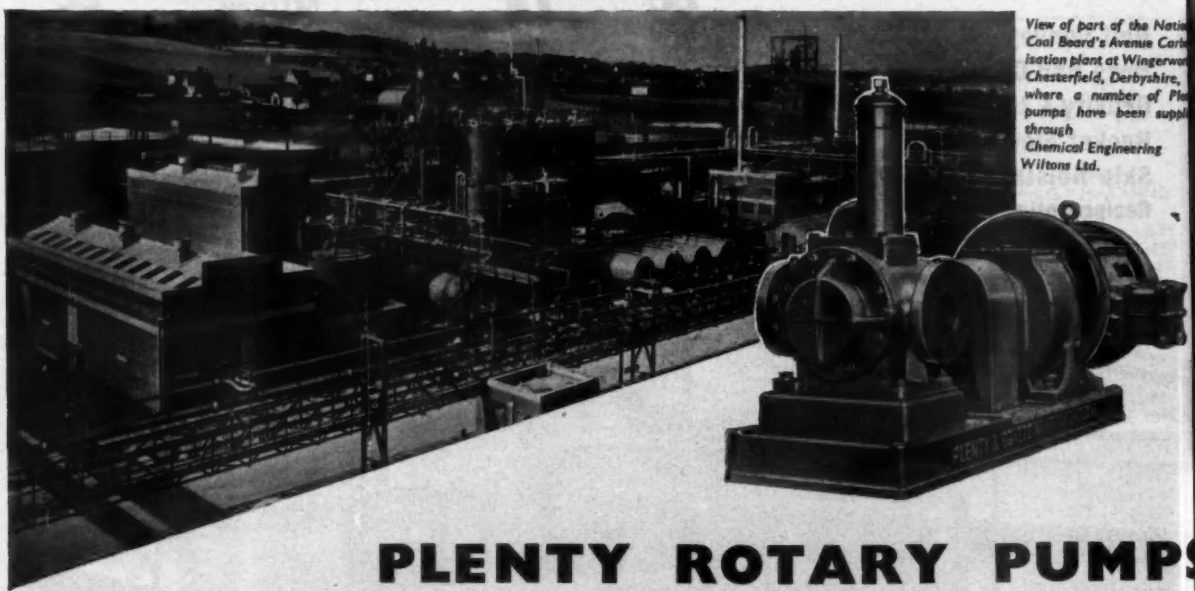


In the 20" × 12" B.J-D Oxide Crusher you have a machine which can be moved about easily and quickly. The picture shows that the bogie height allows a conveyor to be run underneath to receive crushed oxide. This B.J-D crusher and the larger, fixed 33" × 24" incorporate important features: breaker plate is adjustable during operation and can be swung wide open to allow passage of sticky oxide; no screen bars used.

BJD

oxide crushers

BRITISH JEFFREY-DIAMOND LTD.,
CRUSHER AND INDUSTRIAL DIVISION,
15-17 Caxton Street, London, S.W.1.



View of part of the Natio Coal Board's Avenue Carb isation plant at Wingerwo Chesterfield, Derbyshire, where a number of Ple pumps have been suppl through Chemical Engineering Wiltons Ltd.

PLENTY ROTARY PUMPS

Wherever difficult materials have to be handled, there you will find Plenty pum doing the job with efficiency and economy. Our wide experience of Gas Indust problems enables us to find a practical solution to meet most technical requirement Do not hesitate to write. Enquiry entails no obligation.

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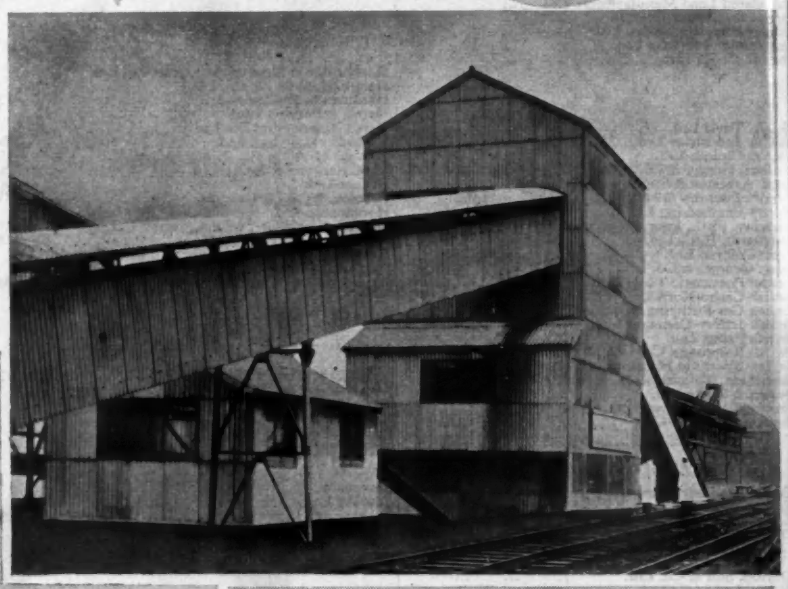

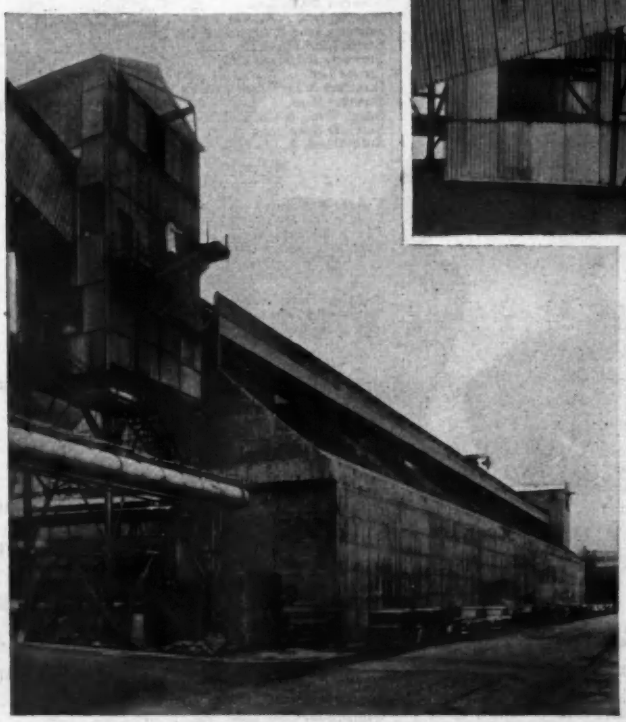

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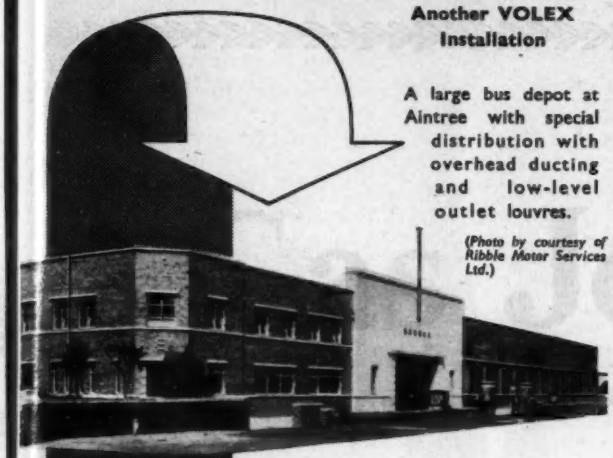

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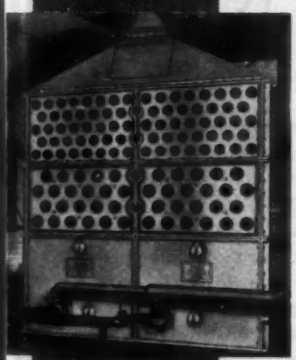

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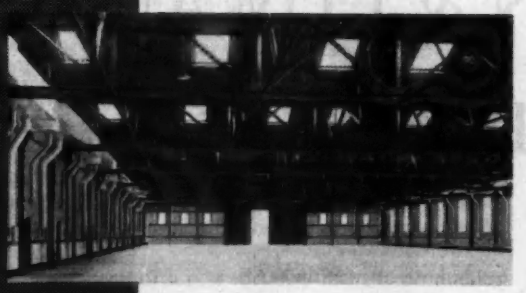

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1957

Gas Journal

VOLUME 292. No. 4922. NOVEMBER 13, 1957. 109th YEAR

Combating Metallic Corrosion

THE particular property of iron to form a compound when it comes in contact with the atmosphere which is physically unstable has been responsible for as much thought and ingenuity on the part of engineers as any problem which they have had to solve since the construction of plant, in whatever form, from iron or steel became commonplace in industry. With the increase in size of plant, it became necessary to build the constituent vessels of a material possessing greater physical strength, and yet preserve the anti-corrosive property of the smaller plant—assuming that this particular property had indeed been solved, to a greater or lesser extent. The development of chemical processes demanding higher temperatures and higher pressures made it more than ever necessary to find a material which would stand up to these far more stringent conditions and resist corrosion both from the constituent reactants taking part in the process and the ravages from the atmosphere outside.

In the gas industry the damage done to iron and steel work is extremely serious, both in the production of gas and in the distribution systems, especially with the development of high pressure grid systems. In the works the main sources of corrosion are the generation of sulphur dioxide and possibly sulphur trioxide in flue gases, the subsequent formation of acids on condensation and the handling of fouled purifier material. This latter may be the cause of much metallic corrosion.

With the advent of a new industry like the production of radio-active isotopes and the production of power from atomic piles, the importance of corrosion prevention and control becomes greater and greater. In fact, so important has it become that a National Anti-Corrosion Week was organised recently, during which a Corrosion Convention was held at the Central Hall, Westminster, and a Corrosion Exhibition at the Royal Horticultural Hall, where those firms which manufacture the means to fight corrosion, exhibited. The convention lasted for two days, during which seven papers were read and discussed. Every aspect of metallic corrosion was covered, varying from corrosion in the shipping industry to corrosion in the atomic energy industry, from hot-dip galvanising to anti-corrosive coatings for buried pipes. With the great variety of exhibits on show at the exhibition and the varied themes of the papers read at the convention, a clear pattern underlying the problems to be solved began to emerge.

In the first place metallic corrosion is a galvanic action involving two metals and an electrolyte of some sort, or is purely a chemical action between an acid and a metal. The conditions under which such reactions take place must be studied and effective avoiding action taken. It may be that metals, such as the noble metals, are unaffected by acids or alkalies, or it may be that certain metals when they come in contact with the atmosphere form a protective surface of oxide or carbonate which is unaffected by further corrosive action.

Where the corrosion is due to galvanic action between two metals and an electrolyte, or to impurities in the metal itself forming a galvanic cell and the surrounding moisture being responsible for the corrosion, a sacrificial anode may be employed which is more electropositive than the metal to be protected; or an electric current may be passed down the metallic object to change its potential in relation to its surroundings.

Bearing these fundamental points in mind, it becomes clear that rust-forming iron and steel objects which do not form a protective surface coating may be treated with some metal that does, or be given a protective coating in the form of painting. In those cases where protective coatings cannot be successfully applied because of the temperature and pressure conditions inside a piece of plant or because of the solvent action of the material being contained, some other material

must be found which is impervious to the operating conditions. Naturally the noble metals, gold or platinum, would be unduly costly, but nickel, stainless steel, titanium and alloys such as monel metal may be used. The protection of ships' hulls or high pressure steel gas mains may be protected by some means of cathodic protection. Plastics, too, may be used as a substitute for iron and steel in the manufacture of gas and water services or as a lining to steel tanks. In the latter case, the steel may be looked upon as a means of physically strengthening a chemically insert plastic tank.

Since oxygen is one of the most important constituents of all corrosive agents, means of eliminating it from the sphere of action are often fruitful in preventing corrosion. This applies to the oxygen dissolved in boiler feed water or the small quantity of oxygen to be found in town gas and its possible corrosive action in conventional gasholders. Sulphur is also an important corrosive agent and is a constituent in all flue gases in varying proportions. Since the presence of oxides of sulphur have a considerable effect in raising the dew point of hot flue gases, attempts have been made to eliminate the sulphur by mixing certain reagents with the fuel to be burnt.

All these points were clearly made in the papers read at the convention, while the exhibits illustrated what is being done in practice. It is of great interest to see what progress has been made in the field of protective coverings, especially in the constituents of modern paints and the manufacture of protective wrappings. In both cases it is often the application or the preparation of the surface before application which leaves most to be desired, and detracts most from what is probably an excellent means of corrosion prevention.

New Thinking on Gas Liquor

IN several respects Mr. W. W. Law's paper to the Eastern Junior Gas Association, which we publish in this issue, is an important one. In the first place, it puts gas liquor back in its rightful place on the industry's map—whence, unfortunately, it is apt periodically to slip into comparative obscurity through an unaccountable lack of enthusiasm, encouragement or intelligible marketing policy on the part of its producers. Secondly, the paper gives some convincing reasons why the trial results (see 'GAS JOURNAL' of June 26, 1957) were so disappointing, and shows how in certain circumstances very different figures might be obtained. And thirdly, the author makes a direct and forceful appeal to the gas industry to set its ammoniacal liquor house in order before this useful fertilizer becomes no more than 'a pleasant interlude, no longer commanding any attention from the farming community.'

His plea is for closer collaboration between the industry and the contractors, for a long-term programme of experimental work, for the setting up of a joint organisation for the collection and dissemination of all relevant information, for advertising on a national scale, and for an agricultural department within the gas industry with experts available to advise both farmers and contractors. Such a plea must command the serious consideration of the industry in relation to a product which it must by this time realise is just as important to one section of the community as gas and coke are to others. But collaboration presupposes a strong and fully representative contractors' organisation, able to speak with one voice on behalf of all concerned. The gas industry cannot be expected to treat independently with numbers of individuals each probably claiming special consideration for his own particular sphere of operations. Negotiations on national policy must be with a representive body to which all liquor contractors should belong.

As regards the trial results, Mr. Law attributes many of the poor figures to excessive scorch caused by using oxidised liquor, rather than to losses by evaporation, volatilisation, or leaching, all of which he maintains are relatively small. If at the works air is drawn into the gas stream at the entrance to the condensers, instead of at the entrance to the purifiers, an oxidised liquor is obtained, which produces excessive scorch. Deterioration also occurs when liquor is conveyed to the site of the trials (as it often is) in metal drums. Also, experiments conducted on small-scale plots with improvised equipment such as garden watering-cans cannot give such satisfactory results as can properly designed commercial spreaders. It is to be hoped that with these points in mind further trials will be carried out as part of the industry's general research programme.

While we endorse in principle Mr. Law's emphasis on the almost all-the-year-round nature of the liquor market—though farmers have not yet fully recognised the fact—his contention that applications can be made to grass *throughout the growing season* should, we think, be accepted with caution. Many would not favour the use of liquor during the most vigorous period of the spring flush.

For weed control on kale the author makes an interesting suggestion in the use of row-crop tackle to flood the spaces between the drills. This doubtless deals effectively with the weeds between the rows and at the same time obviates scorching the crop; but weeds also grow prolifically along the drills with the crop, and these will not be touched by this method. Nor can it be applied in cases where the seeds are put in with a corn drill, as is often practised to get a thicker cover of plant over the field. We sometimes feel that a little too much stress is laid on the scorch bogey. While the use of the normal equipment with splash attachments makes the crop look rather as if a flame-thrower has been across it, recovery is generally absolute and complete within a fortnight, and heavy yields invariably result.

We consider that to obtain the best from liquor as a weed control it should be applied to kale at the 2-4 leaf stage rather than at the 4-6 leaf stage advocated by Mr. Law. If weeds are growing concurrently with the crop there is a better chance of controlling them, particularly in the case of fathen, if the liquor is applied at the earliest possible moment. Mr. Law's experiments on sugar beet will be followed with the greatest interest in all areas where this crop is grown. If adopted generally it will provide a most valuable winter outlet for liquor.

Finally, we commend Mr. Law's proposal for a comprehensive handbook on the production, distribution,

and application of gas liquor to various crops. It is high time all the proved facts were brought together in a form that will be of interest and value to gas engineer, contractor, and farmer alike. In the event, we as the gas industry's Technical Press, with a great deal of basic information on gas liquor readily available in our records, would be the first to offer our collaboration in the preparation of such a publication.

Are Section Programmes Too Narrow?

THE objects and purposes of the Institution of Gas Engineers are "the promotion of engineering science as applied to the gas industry in all or any of its branches, and to facilitate the exchange of information and ideas among the members of the Institution and otherwise on the subjects of improved methods of administration in gas undertakings, improvements in the manufacture and distribution of gas and the resulting by-products, including the manufacture of coke, the manufacture of ammonia products, the production and distillation of tar and the working up of its derivatives, the applications of gas to lighting, heating, production of power, domestic and industrial uses and other purposes, and the construction of gas works and gas appliances . . .' The objects and purposes of the District Sections are much the same.

Doubt whether the London and Southern Section is fulfilling those objects and purposes was expressed by a member at the recent A.G.M. Since the 94th Annual Report and Accounts of the Council of the I.G.E. makes reference to a proposal to revise the syllabuses for the Associate Membership examination 'having regard to the trends in the functional organisation of the gas industry whereby production, distribution and utilisation have become separate specialised branches of the industry,' the complainant felt that the platform of his Section should be open for discussion on matters relating to these three branches of the industry. He had found that the last paper delivered to the Section on distribution had been in 1955 and that it was some years since the Section has received a technical paper on appliance design. In recent years, he said, there had been exciting developments on the utilisation side of the industry, such as the spectacular improvement in the efficiency of gas heaters, the development of special flues, and the introduction of space heating by warmed air. The papers which had been presented relating to utilisation in recent years had in the main been of a commercial and not a technical nature.

We believe the protest was justified and we publish this item as a reminder that in some quarters a little widening in the scope of programmes would not come amiss. An excellent example of how production, distribution and utilisation may be covered is shown by the Autumn Research Meeting programme this year. It is possible to please all the people some of the time.

'Scottish Gas'

AREA board house organs fall naturally into two types—those in the form of small-page magazines, and those designed on the lines of 'popular' tabloid newspapers. Some boards (East Midlands, South Eastern, West Midlands) publish both types, using the magazine variety for general area news and the newspaper type for sales topics. However, like the Eastern and South Western Boards, the Scottish Gas Board, which has just produced its first periodical, *Scottish Gas*, has favoured the newspaper format for its presentation of general news, but it has done more than its sister publications in the way of infusing into its material a strong dose of sales propaganda; it is really a marriage between an area board magazine and a sales newspaper. Edited by Mr. John Clark, Advertising and Publicity Officer of the Board, and designed and produced by Holden's Press Bureau, this is a lively enough publication. If we have a criticism, it is that the striving after newspaper atmosphere should not have been carried to the lengths of producing the publication on newsprint which gives very poor reproduction of half-tone blocks. It is wiser, we believe, to follow the example of the Eastern Board and, while retaining the newspaper 'feel' of the thing, step up the standard of paper used to give satisfactory clarity in the illustrations. Nevertheless, this is a bright production and will no doubt be of interest and value to the 10,500 employees to whom it is to be distributed free. As Mr. Sydney Smith, the Board Chairman, points out in his foreword, the Scottish Board is essentially a *national* organisation. We feel that he has a national gas newspaper of which he may well feel proud.

Problems of Industrial Progress

THE pace of technical change is much faster nowadays than it has ever been in the past. Its effects on industry are great; the effects on human beings may be profound. Research is, of course, going on into these problems. The research workers produce reports on their results—exhaustive and detailed reports that are of great value in stimulating new ideas and new methods of tackling the difficulties. The trouble is that they are, necessarily, too long for managers or trade unionists to read. The people that they most concern and might help are too busy to get down to reading an academic report.

The D.S.I.R. has recognised this. It has just published the first of a new series of publications called *Problems of Progress in Industry*. The booklets will be short and as easy to read as possible. They will, in fact, be 'industrial versions' of academic reports or reviews of comparable research done independently by several teams. The first in the series is called *Men, Steel and Technical Change*. It deals with the changes that have taken place in a firm making steel, especially those in the last 20 years. It is itself a summary of a much longer report published by the Liverpool University Press.

At Last—an Automatic Cooker

IT is often said that the gas industry today is in urgent need of glamour, but what could have been more glamorous than the way in which the North Thames and South Eastern Gas Boards helped General Gas Appliances Ltd. to launch their 'Auto-Range' cooker at the Savoy Hotel last week? This, the gas industry's first fully automatic cooker, was put through its paces in a manner hitherto limited to electric time-switch cookery, and we are happy to report that as Miss Joan Storey unsealed the ovens of the demonstration appliances the food which emerged bore silent testimony to the fact that automatic cooking by gas has really arrived. And about time too!

Mr. Michael Milne-Watson described the cooker as 'our Sputnik' and it is certainly a great advance. In a way it is a pity that the cream was taken off the story of the 'Auto-Range' by giving it premature publicity at the time of the Ideal Home Exhibition. Nevertheless, having such a cooker in our range should prove to be a useful ace in our hand during the forthcoming cooker campaign.

Personal

MR. HAROLD SUTTON, Works Controller at the Trafford Park works of Lancashire Dynamo & Crypto, Ltd., retired on October 31. To mark the occasion, a presentation was made on behalf of his colleagues by MR. A. W. A. DICK-CLELAND, Joint Managing Director.

MR. C. J. STAIRMAND, manager of the chemical engineering research section of I.C.I., Billingham-on-Tees, Ltd., has been awarded a degree of Doctor of Science by London University for his research work into gas cleaning and atmospheric pollution.

MISS K. M. HALPIN, C.B.E., President of the Women's Gas Federation, has been elected a Vice-President of the Federation of Soroptimist Clubs of Great Britain and Ireland.

MR. A. V. NICHOLS has retired after 50 years' service at the Coxside Gasworks, Plymouth. He is succeeded as general foreman by his elder son, MR. A. G. NICHOLS.

A triple presentation was held recently at the Uxbridge clubroom of the North Thames Gas Board when parting gifts were made to three well-known personalities there—all retiring from the Board's service and all with long service. Pictured above, they are (left to right) Mr. J. Woodbridge, distribution foreman at Uxbridge (45 years' service); Mr. G. Rose, foreman at Uxbridge works (37 years); and Mr. G. Quelch, Sales and Service Superintendent at Uxbridge (46 years).

G.C. Dramatic Society

THE Gas Council Dramatic Society is presenting 'Lord Arthur Savile's Crime' at 7.30 p.m. on December 4, at the Institut Francais Du Royaume-Uni, Queensberry Place, S.W.7.

Tickets are obtainable from Miss J. Bolton, 1, Grosvenor Place, S.W.1, at 7s. 6d., 5s., and 3s.

A N.T.G.B. Development

The apparatus for determining H_2S described and illustrated on p. 232 of our October 30 issue, was developed in the Brentford laboratory of the North Thames Gas Board.

Mr. A. McG. Clark, right, is seen receiving a wallet of notes and a fountain pen from Mr. William Kirk, Manager, Glasgow and Western Division, Scottish Gas Board, on his retirement as manager, Port Glasgow, reported in the 'JOURNAL' last week. Pictured with them are Miss M. McKechnie, Secretary, and Mr. L. Bain, Port Glasgow Station Engineer.

Diary

November 15.—JUNIOR INSTITUTION OF ENGINEERS: Pepys House, 14, Rochester Row, Westminster, S.W.1. Ordinary Meeting. Chairman's Address, 'Some Aspects of Town Gas Distribution,' by J. E. Gray. 7.0 p.m.

November 16. — WESTERN JUNIORS: Gloucester. 2 p.m.

November 18.—SOCIETY OF CHEMICAL INDUSTRY: YORKSHIRE SECTION: Joint Meeting with the BRADFORD CHEMICAL SOCIETY in the Technical College, Great Horton Road, Bradford. Presentation of short papers by Members, including 'Town Gas Production in Western Europe,' by P. C. Finlayson. 7 p.m.

November 18.—WEST MIDLANDS G.C.C. Gas Offices, Edmund Street, Birmingham, 3. 2.30 p.m.

November 19.—SOUTH EASTERN G.C.C. EAST SURREY DIVISION. S.E. Gas Board premises, Katharine Street, Croydon. 2.45 p.m.

November 19 and 20.—INSTITUTION OF GAS ENGINEERS: Church House, Westminster, S.W.1. 23rd Autumn Research Meeting.

November 20.—INSTITUTE OF FUEL (MIDLAND SECTION): Imperial Hotel, Temple Street, Birmingham. Joint meeting with the West Midlands Division of the National Smoke Abatement Society. 6.15 p.m.

November 21.—MIDLAND JUNIORS: Visit to the G.E.C. Works, Witton, Birmingham.

November 26.—INSTITUTION OF CHEMICAL ENGINEERS: Albemarle Street, W.1. Joint symposium on recent developments in industrial low temperature gas separation. 9.45 a.m.

November 26.—SOCIETY FOR ANALYTICAL CHEMISTRY: Burlington House, Piccadilly, London, W.1. 6.30 p.m. A.G.M. of the Physical Methods Group. An ordinary meeting will follow with a lecture by the retiring Chairman, Dr. J. E. Page.

November 27.—LONDON AND SOUTHERN JUNIORS: Visit to I.C.I. Technical Service and Development Laboratories at Welwyn Garden City. 2.15 p.m.

November 27.—I.G.E. LONDON AND SOUTHERN SECTION: Pepys House, 14, Rochester Row, Westminster, S.W.1. 'The Organisation of Maintenance in a Large Oil Refinery,' by R. D. Reed. 2.40 p.m.

November 27-28.—INSTITUTE OF FUEL: Institution of Civil Engineers, Great George Street, London, S.W.1. Second conference on pulverised fuel. 10 a.m.

November 28. — EASTERN JUNIORS: Peterborough. Short paper reading competition.

November 29.—JUNIOR INSTITUTION OF ENGINEERS: Pepys House, 14, Rochester Row, Westminster, S.W.1. A.G.M. and annual meeting of contributors to the benevolent fund. 7 p.m.

SOUTH WESTERN SECTION A.G.M.

Retiring Chairman Speaks of Future Management Problems

AFTER tracing the progress of the industry in administration and management since nationalisation, Mr. J. W. Dean, retiring Chairman, stressed the importance of education and training and the selection of personnel for management in his address at the annual general meeting of the South Western Section of the Institution of Gas Engineers at Bath, recently.

Luncheon was taken at Fortts, Milsom Street, Bath, before the meeting, when members were the guests of Mr. C. H. Chester, C.B.E. (Chairman), and members of the South Western Gas Board.

At the meeting, held in the demonstration theatre at Quiet Street, Mr. Dean welcomed Dr. W. T. K. Braunholtz, O.B.E., Secretary of the Institution, as well as three new members.

Election of Officers

Officers elected for the ensuing year were: Chairman, Mr. T. L. Tallentire; Senior Vice-Chairman, Mr. G. F. Oliver, M.B.E.; Junior Vice-Chairman, Mr. A. C. Rea; and Immediate Past-Chairman, Mr. J. W. Dean. Messrs. T. W. Jackson, T. W. Clapham, and O. H. W. Boonham were elected as Ordinary Members of the Management Committee together with Mr. L. Baldwin and Mr. E. Annakin as Honorary Auditors.

The retiring Chairman then gave his address. The search for greater efficiency at a time of growing inflation had resulted in specialisation and functionalisation, said Mr. Dean

Where, with this increasing emphasis on specialisation, were the managers of tomorrow to be found? Opinions on the qualities required in managers varied from the 'nothing to it at all—pick it up as you go along' school to the realisation that management was something of a higher order when properly planned and not just left to happen.

There were two alternatives. Either future managers must be selected during their early days in the industry, given an insight into all functions of the industry, and trained intensively in administration without cutting across basic technical education in gas engineering. Or—vastly inferior both in principle and application — the existence must be admitted of the iron curtains of functionalisation, and, while agreeing the necessity for training in management, it must be given as an afterthought to a greater or lesser degree to all staff entrants to the various functions at some stage in their careers.

The Human Element

Any management could fail in its purpose if it neglected what is its greatest strength or could be its undoing—the human element. Every employee of every industry should feel that his welfare was of the highest importance to his employer.

Mr. Tallentire thanked Mr. Dean for his address on behalf of the members.

In introducing the new Chairman of the Section, Mr. Dean expressed his pleasure that Mr. Tallentire, who was well-known to all members, should be succeeding him.

Mr. Tallentire expressed appreciation of the honour conferred on him and congratulated Mr. Dean on his work during the past session. On behalf of the Section he presented Mr. Dean with a King George II (reproduction) silver cream jug and sugar castor, as a memento of his year of office.

Going Down . . .

A PAINTER employed by the NEGB at Brighouse, 22-year-old old Trevor Lee, fell head first from a 40 ft. gas holder, turned a somersault and landed on his feet on a yard-wide wooden platform more than 20 ft. below.

He was taken to Huddersfield Infirmary where he was treated for abrasions to his right hand. He then returned to work.

A Gas Board official said: 'It was an amazing escape.'

CANNON PROFIT UP £88,000 ON LAST YEAR

Shareholders to Get 5% More than Last Time

A PARTIAL recovery from the severe effects of hire-purchase restrictions last year is suggested by the result of Cannon (G. A.), Ltd., of Bilston, for the period to June 30 last. Group profit before tax is £90,104 compared with £1,847 last year and £323,077 for 1954-55. Tax takes £45,388.

Final dividend on the Ordinary is 10%, making 15% compared with last year's 10% met out of reserves and 30% paid in the two previous years.

Carry forward is £382,886 against £369,439 brought forward from last year.

Last December shareholders were told there had been an encouraging improvement in sales on a profit-making basis in the previous few months.

The annual meeting will be in Birmingham on December 16.

Milford Haven Oil Refinery Gets the Green Light

WILL BE COMPLETED BY 1960

PLANNING permission has been received for the construction of an oil refinery to the west of Milford Haven. The refinery, which is likely to be completed by 1960, will comprise a plant to process 100,000 barrels of crude oil per day. The products will be mainly fuels for transport, and heating.

The permission follows a public enquiry in July into an application by the Esso Petroleum Company to the Pembrokeshire County Council in respect of an area of about 1,000 acres. This application had been referred to the Minister of Housing and Local Government and Minister for Welsh Affairs, Mr. Henry Brooke.

The principal objections to the proposal were on grounds of amenity (much of the site is in the Pembrokeshire Coast National Park) and of the danger of oil pollution. The Minister's letter says he recognises the force of these objections, but is in no doubt that expansion of the Company's products is in the national interest, and that to site the refinery at a considerable distance from the jetty, as had been suggested, would heavily increase the cost of the project. From the point of view of the national economy this would not be justified.

The Minister sympathises with the apprehension lest the waters of the Haven should be fouled by oil, but he understands that where proper care is taken there need be little trouble from this source.

The Company have already enlisted the services of an architect recommended by the National Parks Commission.

Man is Gassed Laying Main

ARTIFICIAL respiration was tried unsuccessfully for an hour on Raymond Broadhead, a maintenance worker, who died after he and four colleagues had been overcome by fumes during the laying of a gas main in Smethwick.

They were working after dusk in a 6-ft.-deep pit beside the factory wall of Tangyes, Ltd., when passers-by noticed they were in difficulties. The other four men were taken to hospital and went home shortly afterwards.

GAS HEATS HUGE U.S. SHOPPING CENTRE BUILT ON HISTORIC ROOSEVELT FIELD

Aerial view of Roosevelt Field shopping centre, at Hempstead, Long Island, New York, just before it began full operation. Since then many more cars have been seen in the parking areas, while 60,000 peak-day visitors go about their shopping. It was from this site that Charles A. Lindbergh started his historic flight to Paris; the 'plane visible in the foreground is the flying replica of his Spirit of St. Louis. The total connected gas load in the project is now approximately 50,000 cu.ft. per hr, with provisions for an ultimate load of 90,000 cu.ft. per hr. Gas is supplied from the 3 mill. cu.ft. holder seen in the background.

GAS space heating is making one of its most dramatic and successful showings in a huge shopping centre that requires a total boiler capacity of more than 40 mill. B.Th.U. Thirty miles from Times Square, the Roosevelt Field shopping centre is now starting its second heating season. It is at Hempstead, on Long Island, New York.

Land area of this project includes 360 acres, with 130 acres allocated to the shopping centre. An industrial centre and an office building are either completed or in advanced stages of construction, to account for the remaining acreage.

The site is truly historic. Roosevelt Field is regarded as the 'cradle of American aviation,' having been the take-off point for notable flights such as Charles A. Lindbergh's. However, there has been no flying from the field since 1951. Now, great jet activity emanates from Mitchel Air Force base, less than a mile away.

Roosevelt Field shopping centre serves Nassau and Suffolk counties, principally. These counties have undergone a tremendous population increase during the past six years, from 1 mill. to 1½ mill. The centre, while characterised as the largest in the world by its operators, is probably to be regarded more significantly as typifying a widespread trend in all the larger suburban areas of the United States.

This shopping centre comprises nine one-storey and one two-storey structures, all devoted to retail selling space. The total of 110 stores has 1.3 mill. sq. ft. of sales floor. A continuous basement, 1,300 ft. by 700 ft., is under the centre. Of course, it is there that the gas heating equipment is located.

Immediately surrounding the buildings are spaces for more than 11,000 automobiles, the principal transportation for the peak-day crowds of more than 60,000 visitors. Canopied sidewalk-malls provide weather-protected walking from store to store. Some malls have planted areas; the overall landscaping of the centre includes an unusual variety and number of trees and shrubs.

Underground truck tunnels avoid the annoyances and obstructions of street-level deliveries and pick-ups.

Retail sales within this centre during the first year are estimated as at more than £28.5 mill. Not all shops were open during the full year, so the expectations for the future are considerably higher.

Steam heat is used in the centre's buildings, from 34 gas-fired boilers. The largest is rated by the engineers and producers, Bryant Manufacturing Company, at just under 4 mill. B.Th.U. per hr. The smallest is at 528,000 B.Th.U. The total capacity has been compared with the requirements for heating 400 'average' U.S. homes.

More than 7,000 ft. of 3, 4 and 6 in. pipe were installed as the underground gas distribution system. This provides

for all existing and proposed buildings. There are 8 pressure control points on the main system. Gas is in the 4 in. piping at between 30 and 40 lb. per sq. in., with further reduction to 20 lb. in the 3 in. piping. This system has a designed capacity of 90 mill. cu.ft. per hour.

Gas is delivered to the buildings through 14 service pipes at a pressure of 5½ in. W.G. Pressure regulators in the basement reduce this to between 3 and 3½ in. W.G.

Each of the building services is double-valved, for shut-offs either inside or outside the basement.

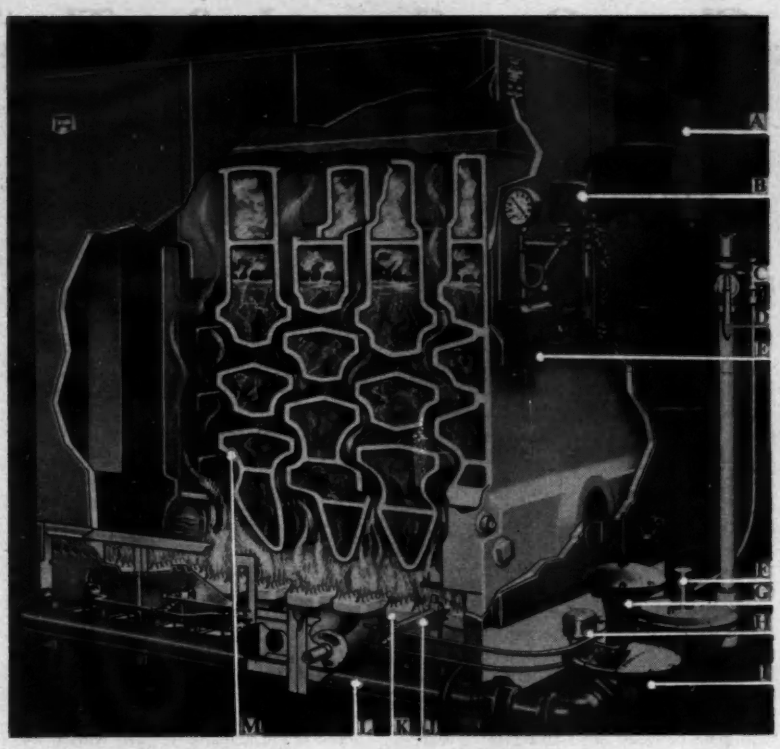
At present, the total connected load is approximately 50,000 cu.ft. per hour. In addition to the 34 boilers, there are a number of water heaters, cookers and other gas appliances. The estimate for the future is a total load of 75,000 cu.ft. per hr., divided roughly to 80% heating and 20% other utilisation.

The gas is supplied to the centre from a 3 mill. cu.ft. holder of the Long Island Lighting Company undertaking. Despite the fact that natural gas is delivered indirectly from the producing areas of the South-Western states by two of the large pipeline systems, this undertaking utilises holders as protection in meeting the demands of peak-periods and as protection against interruptions in the pipeline deliveries.

The 34 boilers in the centre are sectional cast-iron, with thermally-insulated jackets. Room thermostats located in each store comprise the basic operating control.

The thermostat, when heat is required, actuates a magnetic valve which releases a very small flow of gas to the diaphragm valve that controls the main flow of gas to the burners. The small flow from the magnetic valve, creates a higher pressure in the lower chamber of the diaphragm valve. That raises the diaphragm to permit gas flow to the burners where it is ignited by an automatic pilot.

A secondary and mechanical control is co-ordinated to maintain the boiler steam pressure at not less than 2 lb. per sq. in. and not more than 8 lb. This control, called pressuretrol, is an adjustable spring-loaded device that is actuated by steam pressure, through direct connection with the steam dome of the boiler. The high and low pressures are the limits for this control. However, its more important action is set for throttling the diaphragm gas valve to hold the boiler steam pressure at 4 to 6 lb. per sq. in.



Cut-away view of the steam boilers installed at the Roosevelt Field shopping centre. A, draft diverter; B, pressuretrol; C, manual pilot valve; D, manual main valve; E, low water cut-off; F, gas pressure regulator; G, pressure tender; H, magnetic diaphragm controller; I, diaphragm valve; J, automatic pilot; K, gas burners; L, burner and gas control manifold; M, sections, heavy cast-iron tubular type.

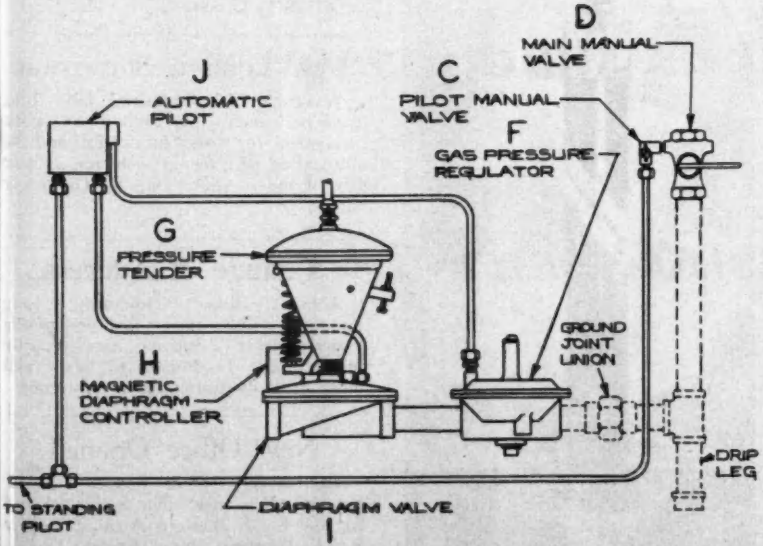
The pressuretrol is set directly on the diaphragm valve, with a rod extending to contact the disc in the diaphragm valve. The diaphragm tends to rise, as a result of the slightly higher gas pressure in the lower chamber induced by the magnetic control valve. The rod from the pressuretrol then causes the diaphragm to act in response to variations in the boiler steam pressure. There is, then, a proportional relationship between the steam pressure and the volume of gas that is permitted to flow to the burners.

When heating requirements set on the room thermostats have been met, the low-voltage circuit to the magnetic valve is opened, thereby shutting off the small flow of gas from this valve to the lower chamber of the diaphragm valve. That valve then seats to shut off gas to the burners until the thermostats again actuate the magnetic valve.

In addition to the pressure regulators on the inside of the basement, reducing the gas to between 3 and 3½ in. W.G., each boiler is equipped with its own pressure regulator. Also, there are manual valves for the main gas and the pilot gas, before each pressure regulator.

The burners are cast-iron, with raised drilled ports. The jackets for boilers are insulated with fibre glass.

The American gas industry may feel justifiably proud of the combined engineering accomplishment of boilers, burners, and control which make up this great project.



Principal combustion control units on the boilers at Roosevelt Field shown in diagram form. Lettering corresponds with that on the cutaway drawing.

Close Our Gasworks?—That's Deplorable!

They Like Gas Lighting in Bingley . . .

THE North Eastern Gas Board received a pat on the back at the Bingley Urban District Council meeting when Councillor A. G. Moorhouse, Chairman of the Lighting and Transport Committee, told the Council that with the monthly inspections Bingley's gas lighting was improving month after month. New equipment had been supplied and he believed the Gas Board was really trying.

Councillor Flanagan had noted that the charge for gas supplied for public lighting purposes would be increased to 15d. per therm from April 1 next year. He wanted to know the cost of the increase to the authority.

Mr. P. W. Bond, Treasurer, said the current charge was 11.71d. per therm. The approximate cost of the increase would be between £650 and £700 a year.

Councillor L. O. Taylor observed that the gas lighting had been in a much better state recently. But for an oversight by the Gas Board the cost should have been increased last year.

FEELING RUNS HIGH IN LEOMINSTER

'OUR gasworks are almost lost,' Alderman F. H. Dale told Leominster Borough Council at a recent meeting. The West Midlands Gas Board intended to close the works within the next few years, he said.

This proposed action was deplored and it was recommended that the Board should be notified of the feelings of the Council members.

'We Protest'

Mr. C. W. Harris, thought 'deplore' was not a strong enough word. 'Protest' should be substituted in the recommendation, he urged.

Alderman Dale said the change was probably due to its being cheaper to import gas from Worcester than to make it in Leominster. 'While we deplore the closing of the works we must recognise the need for overall economy.' Though it would give them temporary embarrassment, Leominster would eventually have cheaper gas.'

His report was adopted.

. . . But they're ashamed of it in Leeds

'LEEDS still has many thousand more gas street lamps than any other large city in the country,' said Councillor L. Lake, Deputy Chairman of the Corporation Street Lighting Committee, after the annual tour of inspection by members of the committee. 'There are,' he added, '16,000 gas lamps and at the present rate of progress it would take 16 to 20 years to change over to electric lighting.

'We have to face the fact that Leeds is behind other cities. We have two things to be ashamed of—our obsolete tramcars and gas lamps.'

Councillor A. Brown, Chairman of the Street Lighting Committee, said his Committee was under the shadow of the 7% Bank Rate. The question was whether they were going to pay for inadequate gas lighting or the 7% rate of interest to install sodium lighting.

Councillor Brown said he favoured the latter idea, adding: 'The sooner we get gas out of the way the better. It is bad lighting.'

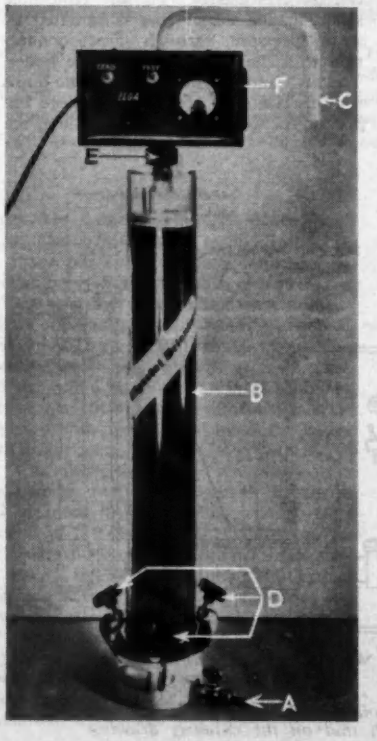
Distilled Water to be had at the Turn of the Tap

A NEW deioniser has been introduced capable of providing distilled quality water at tap speeds, or conductivity water (equal to three distillations in quartz) at the rate of five gal. per hour. This marks a big advance on the tedious process of distillation, while the water complies with the British Pharmacopoeia, effluent quality, indeed, exceeding B.P. specification.

The effluent from this equipment, the Elgastat Major, made by Elga Products, Ltd., London, is free from CO_2 and all other dissolved gases. Ammonia is completely removed and no coloration with Nessler's Reagent is evident. Hitherto it was only possible to produce water of this quality by multi distillation in glass.

In operation, the raw water inlet A, see illustration, is connected to the water mains. Deionised water may then be drawn instantly by opening control valve A. The effluent passes through the conductivity monitor F, so that purity may be checked at any time. The conductivity meter is calibrated from 100,000 to 4 mill. ohms per cm.

When the Elgalite resins are exhausted, cartridge B can be changed within seconds for a freshly regenerated one by releasing the retaining clips D and union E, no regeneration in situ being required.



W-D Get Irish Order

Woodall-Duckham Construction Co., Ltd., has received from the Alliance & Dublin Consumers' Gas Company, Eire, an order for a bench of 24 82-in. lambent heated continuous vertical retorts, complete with step-grate producers and waste heat recovery plant. The installation will be capable of carbonising 194 tons of coal per day, producing 3¼ mill. cu.ft. of 475 B.Th.U. gas.

New London Showroom

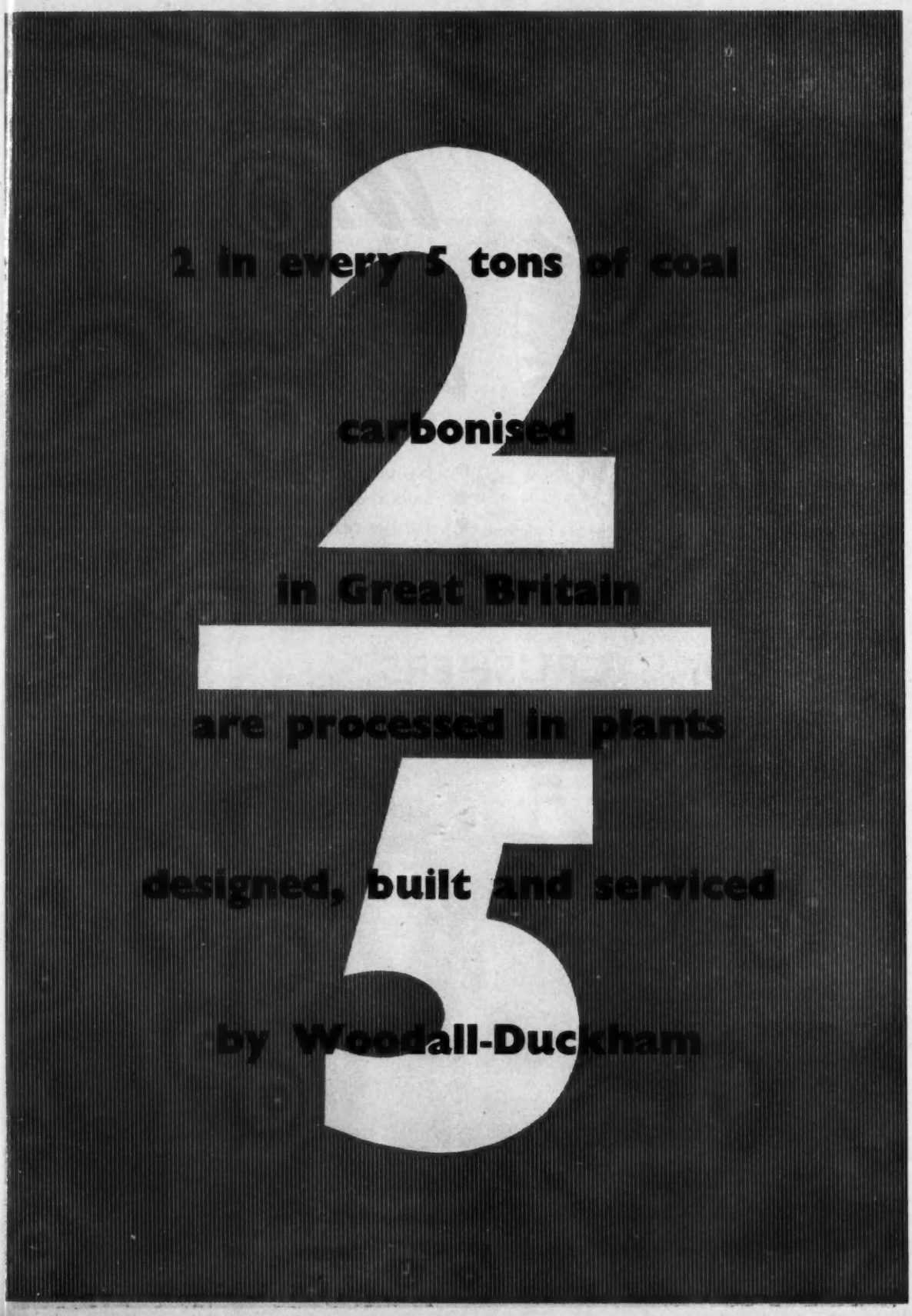
Wakefield-Dick Industrial Oils, Ltd., have permanently on display lubrication equipment for works lubrication and the lubrication of transport vehicles, in their new London showroom in Grosvenor Street, W.1.

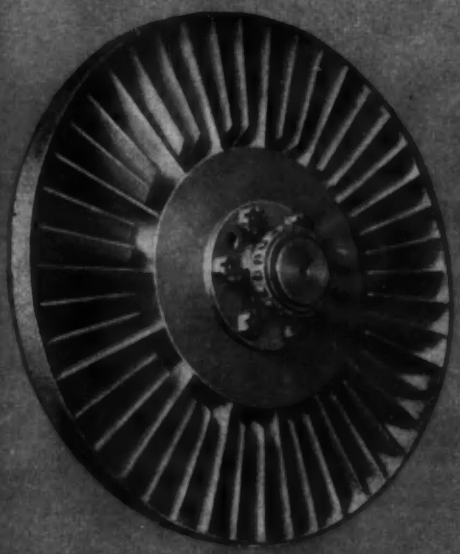
Change of Address

Abbott Birks (Holdings), Ltd., announce that their flexible tubing manufacturing subsidiary have recently moved from Teddington to larger and more up-to-date premises at Guildford.

New Office Opened

The Staveley Iron & Chemical Co. Ltd. has opened a new office and stockyard for the South Western Area at Denver Road, Topsham, Near Exeter, Devon. Telephone number—Topsham 4123.


2 in every 5 tons of coal
carbonised
in Great Britain
are processed in plants
designed, built and serviced
by Woodall-Duckham



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EFFECT OF PRESSURE DISTRIBUTION ON CALORIFIC VALUE OF GAS

By A. PARKER, C.B.E., D.Sc., M.Inst.Gas E.

IT has often been said that compression of gas for distribution causes the condensation of hydrocarbons and results in a lowering of calorific value, sometimes by an appreciable amount. There have been occasions when it has been suggested that the calorific value has thereby been decreased by as much as 10, 20, and even 30 B.Th.U. per cu.ft. on a gross value in the region of 450 to 500 B.Th.U. With the gradual change toward the concentration of gas manufacture in a smaller number of larger, centralised works and the increased use of high-pressure gas mains to carry the gas over considerable distances, it is important to know whether, in fact, compression of the gas does cause so much condensation of hydrocarbon oils in the mains as appreciably to lower the calorific value, particularly with gas that has not been treated for removal of benzole.

Difficulty Involved

With the unavoidable fluctuations, though usually small, in the composition and calorific value of the gas made at the average works, the difficulty of ensuring that samples of the gas collected for examination before compression and at the end of the high-pressure main are from the same part of the bulk supply, and the experimental errors in analysing gas and determining its calorific value by ordinary methods, it is not easy to determine whether compression has caused a fall in calorific value if the change is no greater than 5 or 10 B.Th.U. per cu.ft.

It is no doubt because these difficulties and the overall experimental errors they cause have not always been recognised that the results of tests have sometimes unjustifiably been accepted as proving reductions in calorific value of up to 10 B.Th.U. per cu.ft. Apparent reductions of 20 or 30 B.Th.U. may have been caused by unusual errors of sampling and analysis or by the distribution of a pocket of gas of unduly low quality.

There are, however, two other methods of estimating the probable reductions in calorific value as a result of compression; and the purpose of this article is to describe the two methods, with examples of their application, and to answer the question whether or not compression really can cause an appreciable lowering of the calorific value of gas of the kind distributed in this country.

We shall consider first determination by measurement of condensate. By this method the condensate from the high-pressure main, which necessarily includes a large amount of water, is collected over a measured period of time extending to several days and the oil is separated and its volume measured. At the same time the volume of gas passed through the main is recorded. From the thermal value of the oil collected and the volume of gas, the average loss in the calorific value of the gas can easily be calculated. It is usually sufficiently accurate to assume that the thermal value of the oil is 1.6 therms per gal.

Water Condensation

Incidentally, it may be mentioned that with 1 mill. cu.ft. of gas at atmospheric pressure and saturated with water vapour at 60°F., compression to a gauge pressure of 20 lb. per sq. in. followed by cooling to 60°F. will cause the condensation of about 48 gal. of water. The corresponding amounts for compression to 50 lb. and 100 lb. are 64 and 72 gal. If the 1 mill. cu.ft. at atmospheric pressure were saturated with water vapour at 50°F., compression and subsequent cooling to 50°F. would cause the condensation of 34 gal. of water for 20 lb. pressure, 45 gal. for 50 lb. pressure, and 51 gal. for 100 lb. pressure.

Consideration of Temperature

As compression causes a considerable rise in the temperature of the gas, condensation of water and hydrocarbon oils does not all take place near the beginning of the pressure main after the booster but over a long stretch as the gas is gradually cooled. In one example in which the gas was compressed to a gauge pressure up to 20 lb. per sq. in., the temperature rose as a result of the compression from 63°F. at the inlet to the booster to 150°F. at the outlet. It was not until the gas had travelled about one mile through the high-pressure main that its temperature had fallen to the original of 63°F. Water was condensed along most of the length of one mile, but most of the oil that was collected was condensed in the length of main between 1,000 and 1,600 yds. from the booster. In a series of tests in which gas of a calorific value of 450 B.Th.U. per cu.ft. and consisting of a mixture of coal gas from continuous vertical retorts with carburetted water gas was compressed and passed through this main, the amount of oil collected ranged from 8 to 10 gal. per mill. cu.ft. Assuming that the oil had a thermal value of 1.6 therms per gal. the condensation could only have decreased the average calorific value of the gas by 1.3 to 1.6 B.Th.U. per cu.ft., that is, by no more than about one-third of 1%, which is well within the experimental limit of determination of calorific value. In this instance, the gas had not been treated for the removal of benzole.

Whenever it is alleged that distribution of gas through high-pressure mains has caused an appreciable reduction in its calorific value, the first check should be to measure the amount of oil condensed in the main in relation to the volume of gas passed through it. For each B.Th.U. fall in calorific value, there should be condensed about 6 gal. of oil per mill. cu.ft. of gas. If the amount of oil is greatly below this figure, some other cause of reduction in calorific value must be sought.

More Complex Method

We shall now consider the second method of ascertaining the effect of compression on calorific value, which is by calculation from the composition of the hydrocarbons. It is more complex than that based on the amount of oil condensed in the main. It involves a detailed knowledge of the composition of the gas, particularly of the unsaturated and saturated hydrocarbons, and of the vapour pressures of the constituent hydrocarbons at ordinary temperatures. This method has only become possible as a result of the experimental work on the composition of the hydrocarbons by Professor A. L. Roberts and his co-workers (J. H. Towler and B. H. Holland) as described in the paper

TABLE 1. COMPOSITION OF COAL GAS FROM CONTINUOUS VERTICAL RETORTS, CARBURETTED WATER GAS, AND A MIXTURE OF THE TWO GASES. PER CENT. BY VOLUME.

Gas	*Coal gas*	*Carburetted water gas*	*2 Vols. coal gas plus 1 Vol. C.W.G.*
CO_2	3·49	4·59	3·86
O_2	0·18	0·72	0·36
$C_n H_m$	2·45	8·75	4·55
H_2	55·99	36·48	49·49
CO	14·06	31·29	19·80
$C_n H_{2n+2}$	19·48	9·76	16·24
N_2	4·35	8·41	5·70
TOTAL	100·00	100·00	100·00

presented by them at the Research Meeting of the Institution of Gas Engineers in November, 1956. By means of infra-red spectroscopy, these investigators made detailed analyses of the unsaturated and the saturated hydrocarbons contained in several coal-carbonisation gases and in gases made from petroleum oils. The coal gases included gas from horizontal retorts, intermittent vertical chambers, coke ovens, continuous vertical retorts, and low-temperature retorts; and the gases from oil included carburetted water gas and Segas.

To give examples of the method of calculation of the effect of pressure on all these varieties of coal gas and oil gas would make this article far too long and involved. It is intended, therefore, to consider in detail only the effects on coal gas from continuous vertical retorts, on carburetted water gas, and on a mixture of the two gases.

TABLE 2. ANALYSES OF UNSATURATED HYDROCARBONS. PER CENT. BY VOLUME.

Gas	*Coal gas*	*Carburetted water gas*	*2 Vols. coal gas plus 1 Vol. C.W.G.*
Ethylene	1·16	5·81	2·71
Propylene	0·244	1·32	0·603
Propadiene	0·007	0·040	0·018
Butenes	0·081	0·223	0·128
Butadienes	0 029	0·202	0·087
Pentenes	0·037	0·038	0·037
Pentadienes	0·033	0·107	0·058
Hexenes	0·032	0·012	0·025
Acetylenes	0·077	0·124	0·093
Benzene	0·486	0·597	0·523
Methylbenzenes	0·123	0·210	0·152
Dimethylbenzenes	0·068	0·040	0·059
Trimethylbenzenes	0·011	0·006	0·009
Other compounds	0·062	0·021	0·048
TOTAL	2·450	8·750	4·550

The compositions of the coal gas and the carburetted water gas used for the calculations are the same as those given by Professor Roberts and his co-workers in the paper already mentioned. The results of analysis by the Bone and Wheeler apparatus are shown in Table 1, the last column of which shows the composition of a mixture of two volumes of the coal gas with one volume of the carburetted water gas.

In the gas distributed in this country, the only constituents that are combustible and make an important contribution to the calorific value are the unsaturated hydrocarbons (C_nH_m), hydrogen, carbon monoxide, and the saturated hydrocarbons (C_nH_{2n+2}) including methane. Of these constituent gases, it is impossible to condense hydrogen, carbon monoxide, and methane to liquids at any pressure unless they are first cooled to very low temperatures, far below the freezing point of water. The only constituents that could be condensed to liquids by pressure at any temperature ever attained in a gas main are certain of the unsaturated and saturated hydrocarbons, which are complex mixtures.

The compositions of the unsaturated hydrocarbons as percentages by volume of the gases given in Table 1 are given in Table 2, which is derived from the results obtained by Professor Roberts.

The next step is to ascertain which of the compounds in Table 2 in the concentrations in which they are present would condense, and if so to what extent, when the gases are submitted to the pressures and temperatures probable in high-pressure gas mains in this country. It seems appropriate to make the calculations for gauge pressures

TABLE 3. MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF UNSATURATED HYDROCARBONS AT 40°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Ethylene	100	100	100
Propylene	100	100	84
Propadiene	100	100	58
Butenes	44	23	13
Butadienes	25	13	7
Pentenes	16	9	5
Pentadienes	10	5	3
Hexenes	3·9	2·1	1·2
Acetylenes	100	100	100
Benzene	1·8	0·97	0·55
Methylbenzene	0·50	0·26	0·15
Dimethylbenzenes	0·16	0·09	0·05
Trimethylbenzenes	0·03	0·02	0·01

of 20, 50, and 100 lb. per sq. in., that is, 1.36, 3.40, and 6.80 atmospheres gauge pressures, and temperatures of 40°, 50° and 60°F.

From the figures in Table 2, which are percentages by volume, the partial pressures necessary to maintain the constituents in gaseous form at selected total pressures can be calculated. For example, at 100 lb. gauge pressure (7.80 atmos. true pressure), the partial pressure of the 1.16% of ethylene in atmospheres would be 1.16% of 7.80, that is, 0.0905 atmos. or 68.8 mm. mercury. No condensation at this pressure would occur unless the vapour pressure of ethylene at the particular temperature, say, 40°F., were less than the calculated partial pressure of 68.8 mm. mercury. If the vapour pressure at 40°F. were lower than 68.8 mm. then some of the constituent would condense to reduce the partial pressure to that of the vapour

TABLE 4. MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF UNSATURATED HYDROCARBONS AT 50°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Ethylene	100	100	100
Propylene	100	100	98
Propadiene	100	100	67
Butenes	52	27	16
Butadienes	30	16	9
Pentenes	20	10	6
Pentadienes	12	6	3·7
Hexenes	5	2·6	1·5
Acetylenes	100	100	100
Benzene	2·5	1·3	0·75
Methylbenzene	0·67	0·35	0·20
Dimethylbenzenes	0·22	0·12	0·07
Trimethylbenzenes	0·05	0·03	0·02

pressure. It so happens that the vapour pressure of ethylene at 40°F. is very much greater than 68.8 mm., so no condensation in this case would occur.

By calculating the partial pressures for each constituent at the three gauge pressures of 20, 50, and 100 lb. per

sq. in. in the manner just described, and comparing the results with the vapour pressures at 40°, 50°, and 60°F. as deduced from authoritative tables of data, it can be ascertained whether any of the constituents would condense, and if so to what extent.

Another way of expressing the results is to calculate the maximum percentage of each constituent that the gas would hold without any condensation at the selected pressures and temperatures, and compare the result with the percentage actually present.

In Tables 3, 4, and 5, figures are given for the maximum percentages of each of the constituents in Table 2 that the gas would hold at the three selected pressures and at the three temperatures, without any condensation occurring.

With the exception of the benzenes, the percentages

TABLE 5. MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF UNSATURATED HYDROCARBONS AT 60°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Ethylene	100	100	100
Propylene	100	100	100
Propadiene	100	100	78
Butenes	63	33	19
Butadienes	37	20	11
Pentenes	24	12	7
Pentadienes	15	8	4·5
Hexenes	6·7	3·5	2·0
Acetylenes	100	100	100
Benzene	3·3	1·7	1·0
Methylbenzene	0·89	0·47	0·27
Dimethylbenzenes	0·28	0·15	0·08
Trimethylbenzenes	0·10	0·05	0·03

of the constituents which the gas could hold at the temperatures and pressures considered, as given by the figures in Tables 3, 4 and 5, are all much greater than in the gases shown in Table 2. Even for the benzenes, the amounts present only exceed the quantities that could be held in gaseous form when the gases are compressed to 100 lb. gauge pressure and cooled to the unusually low temperature of 40°F. In such cases, the coal gas would lose 0.02% of dimethylbenzene and less than 0.01% of trimethylbenzene, the carburetted water gas would lose 0.05% of benzene and 0.06% of methylbenzene, and the mixed gas would lose about 0.01% of the methylbenzenes. These losses would reduce the calorific values by no more than 1 B.Th.U. for the coal gas and the mixed gas, but by about 5 B.Th.U. for the carburetted water gas. There remain the complex mixtures, which are not all hydrocarbons, given in Table 2 as 'other compounds.' Examination of the analytical figures given by Professor Roberts suggests that no more than one-half of these compounds would be condensed by compression of the gas and subsequent cooling. If such condensation did occur the calorific value would be reduced further by not more than 2 B.Th.U. per cu.ft.

TABLE 6. ANALYSES OF SATURATED HYDROCARBONS. PER CENT. BY VOLUME.

Gas	*Coal gas*	*Carburetted water gas*	*2 Vols. coal gas plus 1 Vol. C.W.G.*
Methane	17·[illegible]	8·04	14·55
Ethane	1·[illegible]	1·70	1·25
Propane	0·35	—	0·24
Butane	0·093	—	0·062
Pentane	0·068	0·009	0·048
Hexane	0·042	0·003	0·029
Cyclo-hexane	0·002	0·006	0·003
Heptane	0·006	—	0·004
Methyl cyclo-hexane	0·028	0·001	0·019
Octane	0·026	—	0·017
Nonane	0·011	—	0·007
Decane	0·022	—	0·015
TOTAL	19·478	9·759	16·244

TABLE 7.—MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF SATURATED HYDROCARBONS AT 40°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Methane	100	100	100
Ethane	100	100	100
Propane	100	100	71
Butane	50	26	15
Pentane	13	7	4
Hexane	3·6	1·9	1·1
Cyclo-hexane	1·9	1·0	0·59
Heptane	0·84	0·44	0·25
Methyl cyclo-hexane	0·89	0·47	0·27
Octane	0·24	0·13	0·07
Nonane	0·062	0·033	0·019
Decane	0·016	0·009	0·005

It can be concluded, therefore, that under usual conditions of distribution under pressure up to 100 lb. per sq. in. in this country with coal gas from continuous vertical retorts and typical mixtures of such gas with carburetted water gas, the calorific value would not be reduced by more than 2 or 3 B.Th.U. as a result of condensation of compounds in the group classed as unsaturated hydrocarbons.

Gas from horizontal retorts and coke ovens, however, may contain about 0.8% of benzene and rather more of

TABLE 8.—MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF SATURATED HYDROCARBONS AT 50°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Methane	100	100	100
Ethane	100	100	100
Propane	100	100	81
Butane	61	32	18
Pentane	16	8	5
Hexane	4·4	2·3	1·3
Cyclo-hexane	2·6	1·4	0·8
Heptane	1·1	0·59	0·34
Methyl cyclo-hexane	1·2	0·62	0·35
Octane	0·32	0·17	0·10
Nonane	0·095	0·050	0·029
Decane	0·033	0·018	0·010

the various methylbenzenes than in coal gas from continuous vertical retorts. If such gases, unmixed with other gas with lower concentrations of the benzenes and not treated for removal of benzole, were compressed to 80 or 100 lb. for distribution, there could be condensation of unsaturated hydrocarbons at times of cold weather, causing reductions of calorific value in the region of 10 or 12 B.Th.U. per cu. ft. In such instances, it is desirable that the gas should be de-benzolized before distribution under high pressure. Usually, coke-oven gas is debenzolized and mixed with other gas before distribution and it is not the practice to distribute gas at high pressure from horizontal retorts without de-benzolization or mixing with other gas or both measures.

The compositions of the saturated hydrocarbons in the gases to which the data in Table 1 refer are given in Table 6.

In Tables 7, 8 and 9, figures are given for the maximum percentages of each of the saturated hydrocarbons in Table 6 that the gas would hold at 40°, 50°, and 60°F. and at gauge pressures of 20, 50, and 100 lb. per sq. in.

The percentage figures in Table 6 are lower than those in Tables 7, 8 and 9 for all constituents except decane. There would be condensation of some decane from the coal gas at all three pressures at 40°F., at 50 lb. and 100 lb. pressure at 50°F., and at 100 lb. at 60°F. But the maximum reduction in calorific value from this cause would be only about 1.3 B.Th.U. per cu.ft., and this would require a pressure of 100 lb. per sq. in. followed by cooling under pressure to the unusually low temperature of 40°F.

Coke-oven gas and gas from horizontal retorts generally contain smaller quantities of the higher paraffins such as decane than are present in gas from continuous vertical retorts, so that compression to as much as 100 lb. per sq. in. and cooling to 40°F. would not cause the condensation of saturated hydrocarbons from such gases, and consequent lowering of the calorific value of the gas.

It has been concluded from this study of the compositions of the types of gas ordinarily distributed for public supply in this country, that compression of the gas followed by ordinary natural cooling could only cause the condensation of small quantities of benzenes, methylbenzenes, and some other constituents of the unsaturated hydrocarbons, and of decane among the saturated hydrocarbons. Benzene has a boiling point at atmospheric pressure of 80°C. (176°F.) but the various methylbenzenes and decane have boiling points ranging from 110°C. (230°F.) to over 170°C. (338°F.). It is accordingly interesting to observe that when samples of the oil condensate collected in the series of tests mentioned earlier in this article were submitted to distillation tests, none of the oil distilled over below 100°C., only 4% distilled below 120°C., and only about 50% below 170°C.

TABLE 9.—MAXIMUM POSSIBLE PERCENTAGE IN GASEOUS FORM OF SATURATED HYDROCARBONS AT 60°F. AND GAUGE PRESSURES OF 20, 50, AND 100 LB. PER SQ. IN.

Gauge pressure lb. per sq. in.	20	50	100
Methane	100	100	100
Ethane	100	100	100
Propane	100	100	93
Butane	72	38	22
Pentane	19	10	6
Hexane	5·3	2·8	1·6
Cyclo-hexane	3·4	1·8	1·0
Heptane	1·5	0·8	0·45
Methyl cyclo-hexane	1·6	0·8	0·47
Octane	0·44	0·23	0·13
Nonane	0·13	0·071	0·041
Decane	0·050	0·026	0·015

In conclusion, therefore, with gas of the composition ordinarily distributed under conditions in this country, compression up to 100 lb. per sq. in. followed by natural cooling in the pressure main is unlikely to lead to the separation of hydrocarbon oils by condensation in such quantity as to reduce the calorific value of the gas by more than 3 or 4 B.Th.U. per cu.ft., that is, by as much as 1%, unless the gas is mainly from horizontal retorts or coke ovens and has not been treated for the removal of benzole.

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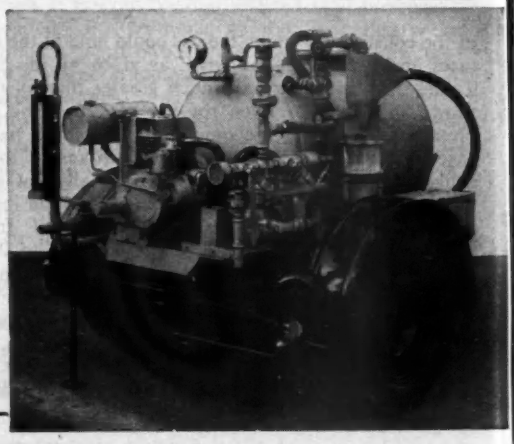
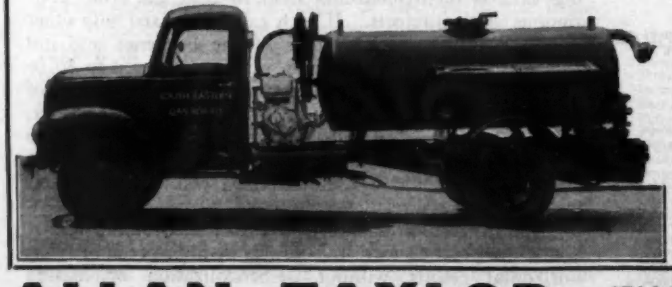


SYPHON EMPTYING OUTFIT



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THE NEW ZEALAND GAS INDUSTRY

Aerial view of Karapiro hydro project on the Waikato River. Output, 106,000 kW.

After spending 18 months in England studying the utilisation of coal, the author, a New Zealand National Research Fellow, reviews the overall fuel position in the Dominion and highlights the important role the gas industry plays in the country's economy.

THIS article has been prompted by the publicity recently aroused by the report of an English expert on the New Zealand gas industry. It is designed to give readers of the 'GAS JOURNAL' a clearer idea of the New Zealand industry than could have been gained from the controversial statements which appeared in the February 20, March 13, and May 15 issues of the 'JOURNAL.' More important, it is designed to correct the impression inevitably gained by those readers that the cause of the industry's plight is wholly and simply a coincidence of collective faults in its management—rapacity, inefficiency, lack of confidence, and lack of foresight.

The author, a New Zealand National Research Fellow, recently spent 18 months in England studying the utilisation of coal, especially complete gasification. The appreciation of the British gas industry gained during this period, together with the prior experience of the industry in New Zealand has left him convinced that the major reason for the lack of development of the New Zealand gas industry has been its reliance on methods of gas production developed in Britain to suit British coals. The future of the industry depends on a bold policy of development with due consideration to New Zealand's peculiar problems of coal supplies and power resources in general.

A general appreciation of New Zealand's specific problems in fuel production and utilisation is essential to an understanding of the gas industry's problems and the overall picture is described briefly here. A more complete description was given by Mr. J. Ivor Graham last year in the *Journal of The Institute of Fuel*, Volume 29.

New Zealand's economy is based almost entirely on her farm produce which comprises about 90% of her exports. The country is approximately equal to Great Britain in area but the population is only about 2¼ mill., of which about two thirds is in the North Island. Some appreciation of the distribution of population can be gained from the map on which the 15 urban areas with populations greater than 20,000 are shown. The figures refer to populations in thousands. The total in these 15 urban areas amounts to about half of the country's total population. The three largest areas of urban development are indicated by the larger circles.

New Zealand's coal reserves are, in general, of much lower rank than those in Britain. The largest class is the 'sub-bituminous' type which is often incorrectly referred to as lignite. The geological history of these coals, which are peculiar to New Zealand, is completely different from that of the Northern Hemisphere coals and they do not fall into any general scheme of coal classification. They generally contain 10-20% of water, are glossy and black (sometimes dark-brown) and although they suffer degradation by weathering they do not decrepitate unduly on heating. They are non-caking.

The estimated reserves of New Zealand coals in millions of tons are as follows:—

	Measured	*Indicated*	*Inferred*	*Total*
Bituminous	40·0	33·0	51·5	124·5
Sub-bituminous	106·2	126·1	307·5	539·8
Lignites	16·3	42·0	310·0	368·3
TOTAL	162·5	201·1	669·0	1,032·6

Bituminous coals occur only on the West Coast of the South Island, in the Greymouth and Buller districts, and only some of them have the specific properties (and sufficiently low sulphur content) for conventional gas production. The West Coast is relatively remote even from the main centres of population in the South Island. Sea transport is complicated by the poor harbour facilities. The two ports are frequently bar-bound, often for extended periods.

The sub-bituminous coals occur in the North Island (Waikato and Taranaki fields) and in the Southern parts of the South Island (Southland and Otago fields). Lignites occur mainly in Southland and Otago but the amount mined at present is relatively small.

The annual production of coal illustrated on the map, is approximately as follows:—

West Coast	1·0 mill. tons (mainly bituminous)
North Island	1·0 mill. tons (all sub-bituminous)
Southland and Otago	·5 mill. tons (mainly sub-bituminous)
TOTAL	2·5 mill. tons

The sub-bituminous coals are more easily won, perhaps 50% being mined by open-cast methods. In general, the cost of mining bituminous coal is much greater and the operation of these mines is subsidised to some extent by the more profitable operation of those producing sub-bituminous coal. About 35% of the coal produced is used in factories, another 35% in general domestic use, 15% is consumed by the railways and about 10% by the gas industry.

In recent years the coal demand for shipping has almost disappeared and the demand by the railways is being reduced rapidly with increased diesel traction. Industrially, there is an increasing preference for oil and in many industries the increased cost is justified by the convenience, cleanliness, and savings in labour. In domestic heating, the demand for coal is being reduced by a rapid increase in the use of flue-less kerosene heaters.

New Zealand is extremely fortunate in her hydro-electric potential and, at present, the amount of electric power produced from other sources is negligible. The present installed capacity is about 1¼ mill. kW. The annual power production from the installed hydro-electric schemes is shown on the map. The ultimate limit of the country's hydro-electric development is debatable—it will be determined by the economic feasibility, some time in the future, of schemes less attractive economically, than those being developed at present. In the North Island the limit may be 1½-2 mill. kW., of which about 1 mill. will be on the Waikato River. The South Island with its snow-fed rivers has a greater ultimate limit—perhaps 6 mill. kW. The distribution systems in the two islands are soon to be connected by a power cable across Cook Strait. Apart from the obvious advantage of transporting power from its source to the user, such a cable could justify the early installation of some of the large hydro-electric schemes, low in capital cost, whose development would otherwise be precluded by the period of uneconomic operation before the demand for power increased to the installed capacity.

In such a young, rapidly-developing country, it is not surprising that the availability of capital has not been able to match the demand. The lack of money for hydro-electric development has limited the installation of power schemes and for the past 12 years there have been recurring shortages of electricity. The present rate of increase in the demand for electricity is about 8% per year and it has been estimated that the installed generating capacity by 1975 must be increased to 3½ mill. kW. The development of power production between now and 1975 is expected to cost some £400 mill.

Only Way

A coal-fired power station of 180,000 kW. is being installed on the Waikato coal fields and should be operating partially in 1958. It is generally regretted that economic stringency in the past has brought conditions where such a station is the only way of meeting the immediate demands for electric power. The capital cost of the installation is little less than that of a hydro-electric scheme, and the production cost of power is more than twice as great. The annual coal consumption of this station will be 600,000-800,000 tons—the increased markets should be welcomed by the coal industry.

Geothermal power at Wairakei is being developed and the construction of the initial generating plant (150,000 kW.) has been commenced. Unofficial estimates of the ultimate contribution of geothermal power vary between 300,000 and 1,000,000 kW.

The future plans for electricity production are concentrated mainly on hydro-electricity, and the linking of the two islands by power cable is of utmost importance. An oil-fired gas turbine station is to be installed for peak load operation. The power authorities have prudently adopted a 'wait-and-see' attitude regarding nuclear power—it obviously cannot compare with hydro-electricity until the capital cost of plant is considerably lower.

The industrial consumption of electricity amounts to about 25% of that produced. The domestic consumption is approximately 66%—about a half of this is used in water heating. The shortages of power in the last 12 years and considerations of load factors have dictated the official policy of limiting, as far as possible, the use of electricity in space-heating.

The present average cost of power to the general domestic consumer is 0.96d. per kWh. or 28.1d. per therm but the higher cost of industrial power increases the overall average to 1.12d. per kWh. A change in the cost structure which is to occur early in 1958 is expected to increase the cost of electric power to the consumer by about 20%.

The annual importation of oil, for uses other than in internal combustion engines and in shipping, is of the order of 200,000 tons. As described above, the preference for oil over coal is increasing the demand both industrially and in domestic space heating. In this latter case, the use of electricity is discouraged and gas is generally too high in cost and, in many areas, is not available.

The gas industry consumes about 10% of the coal mined and the 30 odd undertakings produce a total of 5,000 mill. cu.ft. of gas per year. The thermal value of the gas sold is equivalent to about 15% of the thermal value of the electricity sold.

The largest works has an average daily make of 4 mill. cu.ft. and supplies about 45,000 consumers. Even after being reduced by various indirect subsidies the cost of bituminous coal at this works is 132s. per ton which is approximately twice the price of the coal at the mine. The price realised for coke is about £8 per ton.

The proportion of gas used industrially is small and this is confined to certain specific industries in which alternative fuels are unsuitable. Domestically, gas is used for space-heating, water-heating and cooking. The industry relies upon West Coast bituminous coals although the blending of about 30% of sub-bituminous coal with swelling coal is now being practised in some works.

Turning to the problems of the gas industry, there can be no argument as to its lack of economic soundness. Gas production is maintained by Government aid amounting annually to about £¼ mill. The payment of these direct and indirect subsidies is essential to the continuance of gas supply and is justified by the country's dependence on the contribution made by gas to the overall power supply position. If gas production ceased, the electricity generating capacity might have to be increased by 20%.

There are two basic reasons for this sorry state of the industry. The first is the high cost of mining the specific types of coal required for carbonisation and of transporting these coals from the remote West Coast to the centres of population. The second reason is the competition which gas has had to face from cheap hydro-electric power. The price margin has been increased by the power authorities' policy of reducing the cost of domestic power at the expense of industrial electricity.

In the face of these two factors the position of gas has steadily deteriorated—electricity production is increasing at about 8% per year but gas production remains stationary. There are many secondary effects which have aggravated the position. The lack of a sound economic basis has prevented the natural expansion which would have reduced the cost of gas. The economic stringency arising from these conditions has prevented the proper maintenance and the new development so essential to efficient operation. The working conditions, meter repair and maintenance, in fact the entire industry have been adversely affected. In many cases the management have been so concerned with little day-to-day problems of making gas that they have had to neglect their duties of management and of formulation of policy.

These are the conditions which have led to the recently expressed opinion that the industry has 'thrown in its hand'—conditions due simply to the initial small margin between electricity and gas costs.

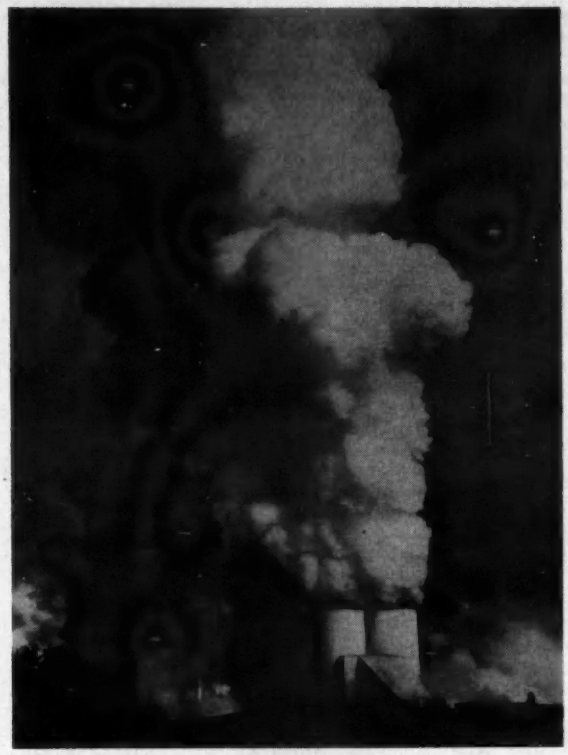
Must Continue

If there is no fundamental change in the operation of the gas industry, this trend of deterioration must continue and the life of the industry will be determined merely by the inability of the electricity supply authorities to meet the demand for power. The expected increase in electricity costs should not, on its own, have much effect.

However, there are two factors which could alter the economic structure of the gas industry and a policy based on the full appreciation of either of them could justify or obviate the payment of subsidies required for the continuance of the industry. A policy which realised the benefits obtainable with respect to both these factors could permit the expansion of an economic gas industry of greatly increased importance to the overall power supply position. These two factors are the co-ordination of gas and electricity supplies and the gradual transition to methods of gas production better suited to the country's coal resources.

The necessity of maintaining the gas industry because of its contribution to the country's power supply has led the Government to encourage the acquisition of the existing gasworks by electricity supply authorities—local bodies, 80 in number, who distribute electricity purchased from the national body which produces it. The advantages in the reduced costs of distribution, meter-reading, accounting, etc., are obvious.

A committee was appointed to examine individual gasworks and to decide in which works gas production should be continued. All except three works were declared essential. Legislation was passed which permitted the electricity supply authorities concerned to acquire gasworks. There has been a considerable amount of negotiation but, as yet, only in one case has the ownership been changed since the legislation was enacted.



Geothermal development at Wairakei—silencers installed on a recent bore.

The most important advantage of gas over electricity is that it can be produced at a constant rate, stored and used as the demand dictates. On the other hand, electricity must be produced as it is required, and it is necessary to install generating capacity equal to the peak load instead of the average load over the day. This factor has been of little significance in the past when electricity and gas have been competing for business irrespective of the type of load.

The improvement of the electrical load factor has always been important to the electricity supply authorities who buy power on a price structure designed to encourage high load factor operation. For this reason, cooking and, more especially, space-heating loads are really an embarrassment to the electricity suppliers. On the other hand, water-heating in storage water heaters with 'ripple control' is a most convenient load for electricity, improving the load factor of operation.

Even if the gas industry were to expand greatly, its contribution to the overall power supply position would still be a minor one but the importance of this contribution would be greatly increased if gas were used in a properly integrated system of power supply to reduce the peak loads which have such an adverse effect on the economics of electricity supply. Gas should thus be favoured for loads such as cooking and space-heating, and all the gas available for domestic use should be used in such applications so that the electrical load factor may be increased. The load factor of domestic gas usage might thus be as low as 20% but the lower the load factor the more important the contribution of gas will become. Any comparison of costs under these conditions must be based on the cost of electricity, used at the same load factor as the gas. The cost might be even as high as 3d. per kWh. High electrical load factors will become even more important in the future when electricity is generated from sources other than water power.

Developments overseas which have shown the practical and economic feasibility of complete gasification as an alternative method of town gas production are of special interest to New

Zealand. The important feature of complete gasification is that it can extend the range of gas making coals to include all North Island coals and many of those of the South Island.

The need for complete gasification is more urgent in the North Island than in the South. The limited hydro-electric potential in the North Island makes gas production more important there, and higher coal transport charges are reflected in higher costs of gas manufacture. At present, the North Island produces about 70% of the total gas of the Dominion.

There are two methods of complete gasification which could be applied to New Zealand—cyclic gasification and high pressure gasification.

Cyclic gasification in the form of conventional water-gas plant is used in several New Zealand works to augment gas production during peak periods and to balance gas and coke sales. For operation with coal the most suitable cyclic plant is a water-gas plant modified to recover as much of the volatile matter as possible from the coal. A vertical retort is mounted above the gasification chamber and the coal passing downwards is carbonised before being gasified.

Cyclic gasification could be used for local gas manufacture on any required scale. Capital costs, labour requirements and costs of gas production are considerably lower than with conventional methods of gas production. The one disadvantage of cyclic gasification is that the gas produced from the coal has a calorific value of only 350 B.Th.U. per cu.ft. and must be enriched by carburation with oil to 450 B.Th.U. per cu.ft. —the normal standard of town gas.

Well Suited

Because these plants can be readily shut down and started again they are very well suited to operation at low load factors and their flexibility will be a valuable factor in the new conditions of operations which will come from the integration of gas and electricity supplies. In fact, their suitability to intermittent operation suggests that it may be possible in the case of small works to produce the day's gas requirement in one operating shift and thus to reduce substantially the labour costs of gas production.

In the case of high pressure gasification (the Lurgi process) a different set of circumstances obtains. Lurgi gas could be produced very cheaply, but this low price depends on large-scale operation. One of the advantages of high pressure gasification is that the gas is available at pressures of about 400 lb. per sq. in. for transmission by high-pressure pipe-line—the gas producers can be situated at the coal mine and the gas piped to the area of consumption even 200 miles distant, at a cost considerably lower than the transport cost of the equivalent amount of coal. The most obvious application of a Lurgi plant in New Zealand is on the Waikato coal fields to supply gas by pipe-line to Auckland and Hamilton. The Lurgi process gives a very clean gas of high heating value, interchangeable with coal gas at approximately half the cost of present-day gas manufacture.

It is generally recognised overseas that the minimum economic size of a Lurgi installation is about 15 mill. cu.ft. per day —whereas the present average demand for gas in Auckland is only a quarter of this. The criterion of economics in gas production is much lower in New Zealand than in the countries where this minimum limit has been established but nevertheless a large increase in the gas demand in Auckland would be essential to the economic operation of a Lurgi plant. If a plant of about 15 mill. cu.ft. per day is installed the initial operation at outputs below the installed capacity obviously cannot be avoided, but this factor should not prevent the installation.

The demand for gas could readily be increased by the initial development of a limited industrial load in Auckland of about 5 mill. cu.ft. per day. With this load, the immediate demand for gas would be more than half the installed capacity, and the financial loss incurred in selling the gas at the price estimated for full-scale production would be less than the financial aid required at present to maintain gas production in Auckland and Hamilton. The availability of Lurgi gas of high quality and low cost should ensure the natural development of demand up to the installed capacity. This development may take five or ten years after the installation is complete—the time required will depend largely on the policy adopted by the power authorities and on the electricity supply position.

In Britain, oil gasification has been increasing rapidly because of the availability of medium and heavy fuel oils and because of the lack of coal for the gas industry. The oil gasification plants operate on a cyclic principle and the requirements of capital charges and labour are similar to those for the cyclic gasification of coal. Gas production from oil in New Zealand would undoubtedly be cheaper than gas production in conventional carbonisation plant, but when oil gasification is compared with coal gasification (cyclic or Lurgi plants) there are no advantages to justify the use of imported oil rather than the use of indigenous coal.

Complete gasification processes yield no coke—this is a slight disadvantage which, however, should be kept in its true perspective. It must be realised that the sale of coke is essential merely to the economics of conventional gas-making. In New Zealand there is no general demand for a smokeless solid fuel as in Britain. Any transition in methods of gas production can only be gradual and the installation of complete gasification plant should, in fact, cause an initial increase in the overall availability of coke—the effect of complete gasification in replacing water-gas plant in large works should be greater than its effect in replacing carbonisation plant in the smaller works.

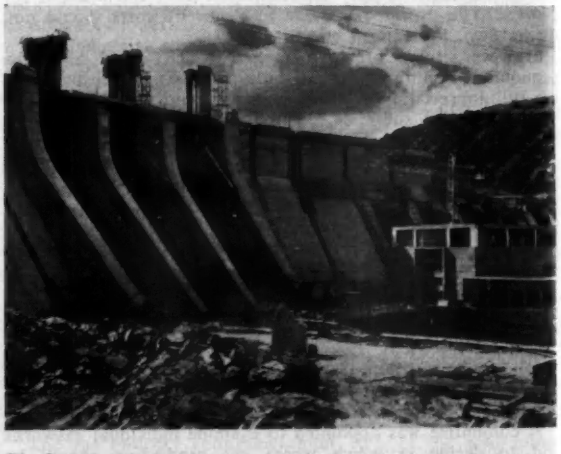
Any comparison of costs of different fuels is complicated by many factors such as the location, efficiencies of utilisation, the suitability in a specific application, possible variations in costs, distribution costs, operating load factors and the units of heat and power employed.

The best common basis for the comparison of different fuels (including cases where no practical experience of costs is available) appears to be as pence per therm into a distribution system. The following table shows this comparison for electricity, gas (conventional methods), Lurgi gas, 'cyclic' gas, and kerosene for space heating. The costs of electricity and gas are based on a reasonable load factor of operation, 60%. An assumed efficiency of utilisation, in space heating is shown for each fuel and the costs on an 'as-used' basis are shown.

	Pence per therm	*Appliance Efficiency*	*Pence per therm as used*
Electricity (present costs to supply authorities	15·8	95%	16·6
with 40% projected increase)	22·1	95%	23.3
Gas (present costs from carbonisation) ..	20·0	75%	26·7
Lurgi gas (estimate based on overseas information)	10·6	75%	13·1
'Cyclic' gas (estimate based on overseas information)	14·4	75%	19·2
Kerosene (flueless appliance)	17·1	90%	19·0

Coal has not been included in this comparison of costs because the inconvenience factor with coal is completely different from that of the fuels considered and because the cost per therm 'as-used' can vary so much depending on the appliance.

The cost of kerosene for domestic heating varies depending on the condition of purchase. The cost has been based on a figure of 2s. 6d. per gal. for the purchase of small quantities in a general store with the customer providing the container. In order to give a similar basis of cost into the distribution system.



Final stages of construction of Roxburgh hydro project on the Clutha River (South Island) which commenced operation in 1956. Spillway, dam, penstocks, and power house can be seen. Ultimate output will be 320,000 kW.

the retailers' profit (assumed to be 10%) is regarded as a distribution cost and the cost into the distribution system is reduced by this amount.

This comparison of costs at similar load factors shows that Lurgi gas is considerably cheaper than all the other fuels. 'Cyclic' gas and kerosene are approximately equal in price, a little below the future promised cost of electricity. For cooking, the margin between costs 'as-used' of gas (Lurgi and cyclic') and electricity becomes greater when the appliance efficiencies are more similar.

The above comparisons of costs have been made at load factors of about 60% but at lower load factors the price margin of gas over electricity is increased. Load factor improvement has always been a problem of the electricity supply authorities and with the installation of base-load plant—coal-fired and geothermal stations—its importance will be greatly increased. Largely on this account, the installation of peak-load electrical plant of about 100,000 kW. has been approved. The most suitable peak-load electricity plant is a gas-turbine—the capital cost is low and such plants are well suited to intermittent operation. The low thermal efficiency is relatively unimportant in peak-load plant.

It is felt that a policy of electrical generation on a large scale for peak loads would remove in part the justification for the continuance of the gas industry and from an overall point of view is not advisable. The advantages of gas production over peak-load electricity production are illustrated by the following table comparing costs of power production in a gas turbine, a Lurgi plant and a cyclic gasification plant, all operating at low load factors. The comparison of capital and production costs is on the basis of power utilised—the overall efficiency of electricity utilisation is assumed to be 100%, and that of gas 80%.

	Gas Turbine	*Lurgi Plant*	*Cyclic Plant*
Capital cost —pounds per installed kW..	43	27	20
Production cost —pence per therm utilised			
at 10% L.F.	62	33	45
at 30% L.F.	47	18	25

The above comparison takes no cognizance of:—

(1) The ability of gas-making plant to produce gas at a constant rate during the day and to meet peaks from the gas-holder reservoir.

(2) The considerable increase in annual load factors possible with gas production if part of the gas is used as an industrial fuel.

(3) The unsuitability of gas turbine plant to operation at anything but low load factors. Any future power shortages would inevitably increase the operating load factor above the design figure.

(4) The effect on the national economy of the importation of the required quantity of fuel oil.

In the past, the price of gas has precluded its use industrially except in a few industries where alternative fuels were unsuitable. The availability of cheaper gas, especially Lurgi gas which should be produced at half the price, would bring a rapid increase in the industrial demand.

The development of industrial load is most urgent in Auckland because such load is essential to the economics of the proposed Lurgi plant. Fortuitously, Auckland (and the long narrow area to the South through which the proposed high pressure main would approach Auckland) is the area of greatest development of secondary industry.

In general, the fuel costs in these light industries are a small part of the total cost of the manufactured product and there is a preference for oil over coal as the industrial fuel (generally for steam raising). The same conditions should create a preference for Lurgi gas over oil because of the greater convenience, cleanliness and ease of control. If Lurgi gas were available the coal industry could supply on one hand, the cheapest fuel and, on the other, the highest grade fuel.

The following table shows a comparison of costs of slack coal, oil and Lurgi gas in Auckland on an 'as-delivered' basis and on an 'as-used' basis, with assumed efficiencies for (say) steam production of 60%, 70% and 80% respectively. (The cost of gas is taken as the estimated cost of Lurgi gas in the high-pressure main in Auckland. Costs of piping, meters and burners are regarded as installation costs).

Fuel	*Cost 'as delivered'*	*Cost 'as-used'*
Coal	6·2d. per therm	10·3d. per therm utilised at 60%
Oil	8·5d. per therm	12·2d. per therm utilised at 70%
Lurgi gas	10·6d. per therm	13·3d. per therm utilised at 80%

The realisation of the higher efficiencies possible with Lurgi gas in industries requiring large quantities of hot air and hot water, would decrease the cost 'as-used.'

Although the cost of gas production in cyclic gasification plant makes such gas less attractive economically than Lurgi gas there are many industrial applications where 'cyclic' gas would be preferred to coal or oil in areas other than Auckland. The importance of industrial load in increasing the load factor of gas usage and the importance of the availability of a high-grade industrial fuel produced from indigenous sources cannot be over-emphasised.

The low density of urban population in New Zealand cities and towns causes high distribution costs whether the service be electricity, gas or water. There is little comparative information available on electricity and gas distributions costs but the margins between production costs and selling costs suggest that, at present, the distribution costs are comparable.

One of the major obstacles to the future development of the gas industry is the belt of recent housing, not reticulated with gas, through which gas must be transmitted if it is to be available in the present housing development beyond. The sprawling nature of New Zealand towns and the development, in some cases, of suburbs perhaps ten miles from the central manufacturing plant suggest the desirability of high pressure gas transmission in welded steel pipe to small suburban low pressure distribution systems. A further application of high pressure gas transmission, already mentioned, is the transport of Lurgi gas from the Waikato to Auckland.

The use of high pressure gas transmission to permit the supply of two reticulation systems from one large central works is limited in New Zealand by the relatively great distances between towns, but as recommended by Haynes, such high pressure transmission systems should be installed, where applicable, as soon as possible.

Opposition to an integrated system of power supply which requires the distribution of two different fuels (electricity and gas) is often expressed. Obviously the ideal system is one relying only on electricity, but experience of power shortages and, more important, considerations of load factors have shown that some alternative form of fuel is essential for the space heating load of which electricity has been able to satisfy only a small part. The installation of a gas distribution system could thus supply an indigenous fuel as an alternative to imported oil in space-heating and could also improve the load factor of electricity by taking the cooking load and that part of the space-heating at present satisfied by electricity. Such a distribution system could also supply gas to meet the increasing demand for a high grade industrial fuel.

The Future

Consideration of New Zealand's resources and of the future development of the country suggests that the gas industry should adopt, as a long-term policy, a scheme for the eventual installation of several Lurgi plants on coalfields supplying gas by high pressure pipe-line to the centres of population—one in the Waikato fields supplying Auckland and Hamilton, one on the Taranaki (or Waikato) fields supplying Wellington, New Plymouth, Wanganui, and Palmerston North and one on the Southland or Otago fields supplying Invercargill and perhaps Dunedin. Of these schemes, only the first is immediately feasible and it would not be possible to develop the others until the gas consumption in the areas concerned was greatly increased.

The installation of cyclic gasification plant is thus desirable, not only because of the gas it supplies immediately for peak-load domestic consumption and for industrial use, but because the improved economics of gas production will permit the natural development in the demand for gas to the stage where the supply from Lurgi plants is economically feasible in most of the larger urban areas.

High pressure gas transmission, even with low-pressure methods of gas production should be used to reduce the problems of transmission to distant suburbs and to permit, where possible, the integration of two distribution systems. The installation of such high pressure systems can be regarded also as part of a long-term policy, for application eventually with Lurgi gas.

To conclude, the advantages to the national economy of an expanding economic gas industry are manifold:

(i) The gas industry, even operating as at present, must be maintained because its contribution to the country's supply of power is essential. The industry could readily be reorganised on an economic basis and the need for financial aid could be obviated.

(ii) Properly integrated with electricity, gas could play an important part in reducing the production cost of the major partner in the amalgamation. The need for peak-load electricity plant, so expensive in operation, could be largely eliminated.

(iii) The installation of gasification processes would reduce the importation of oil for industrial and domestic use. Gas is a higher grade fuel and the reasons for the preference of oil over coal will ensure a preference for gas over oil. The prices are comparative and it is generally accepted that oil will increase steadily in price in the future.

(iv) Two major factors preventing the development of the New Zealand coal industry are firstly, transport, and secondly, the inability to supply the high grade fuel being demanded by the industrial and domestic consumers. Both of these problems which will become more serious in the future, could be largely solved by the large-scale development of complete gasification.

(v) The production of electricity is a most inefficient method of utilising coal. The equivalent power could be produced in a Lurgi plant from half the quantity of coal, and the production costs would be approximately halved.

(vi) The availability of capital which has limited the rate of development of power schemes in the past will still be an important factor in the future. The capital costs for gas production are about one-third of that of current hydro-electric development and about one-half of that of peak-load gas turbine plant.

Appreciation of these many advantages indicates the need for the expansion of the New Zealand gas industry. Plans for the amalgamation of electricity and gas supplies are in hand and the need for the gradual transition in methods of gas production is being realised by the industry.

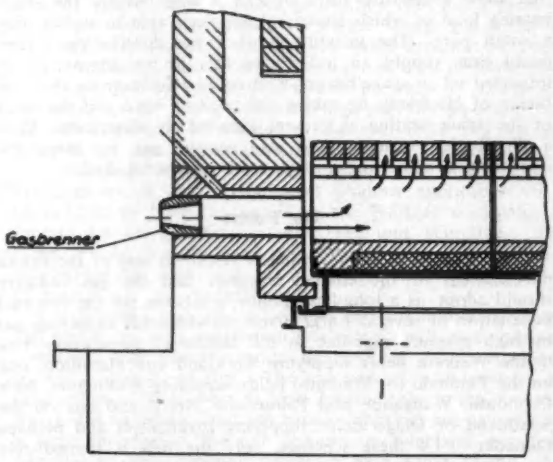
The formulation of a long-term policy on a national basis for the development of the industry is urgently required and the present transitional stage offers a unique opportunity to inaugurate such a policy.

Perhaps the most important requirement of such a policy is its boldness and its confidence in the future of gas—a future which depends simply on the availability of capital for its new development. The capital requirements are trivial in comparison with that allocated to the future development of electrical generating plant.

GAS ON THE CONTINENT

Stress Relief Annealing

LARGE boilers and other large welded or fabricated parts have to be annealed at temperatures between 450 and 650°C. in order to relieve all stresses which may have been set up during the welding process. Apart from an absolutely even temperature distribution, the annealing must be done in a carefully controlled atmosphere so that surface oxidation is eliminated. Gas furnaces have become popular for these purposes, because their effective utilisation of the calorific value in every lb. of coal amounts to 50%, compared with 30% for coal-fired and 20% for electric furnaces, and because the gaseous medium needs no artificial means to create a proper circulation and heat flow due to convection.



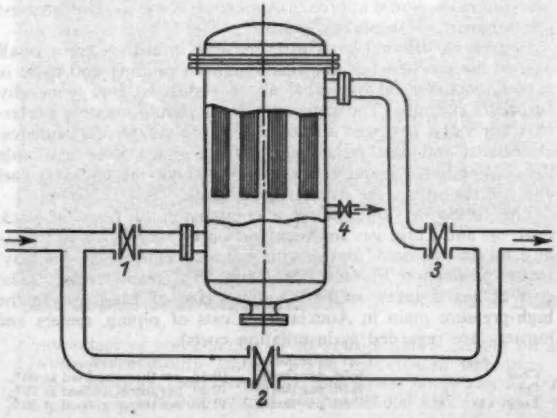
Recently a number of large gas furnaces have been built with capacities of 10,000 cu.ft. useful volume to take boiler drums from 60 to 120 ton weight on a bogey, writes *G. Herrmann* in the July 7 issue of *Gas-Warme*. The illustration shows a section through a bogey of 16 to 20 ft. width which is heated over its whole width by a chequer-work structure of fire bricks (*gasbrenner* = gas burner). Such furnaces have a nominal gas consumption of 31,000 cu.ft. per hour at pressures of 4 in. W.G. The normal working temperature is 620°C. (occasionally up to 1,000°C.) with the air preheated to 275°C. in two recuperators. The temperature is automatically controlled in three zones by electric solenoid-valves and within four hours after starting a maximum variation of 4°C. up or down is reached. The waste gas ports are arranged immediately above the bogey hearth, as can be seen in the illustration, and are joined at the furnace crown into one common flue which leads to the recuperators and to the chimney.

Ceramic Gas Filters

CERAMIC gas filters have been found satisfactory in long-distance gas pipelines for removal of fine impurities which would otherwise pass into the measuring instruments or into consumer's burners, write F. Herning and H. Bellenberg in the August 2 issue of *Das Gas- Und Wasserfach*. The pressure loss across the filter indicates when its pores have become clogged and the elements need cleaning.

The illustration shows an arrangement of such a filter in which the elements can be cleaned by reverse flow so that the filter can work for much longer periods before it has to be taken off for maintenance purposes. The ceramic elements are cylinders of 0.39 in. wall thickness, closed at one end, through which the gas normally flows from the outside towards the inside so that the fine dust is deposited on their outer walls. The coarse dust accumulates at the bottom of the filter tank.

Gate valve 2 and exhaust cock 4 are normally closed and valves 1 and 3 open. When the pressure loss reaches 3.15 in. W.G., valve 2 is opened and valve 1 shut. When valve 4 is opened, the gas in the tank escapes and the back-pressure from the outlet pipe causes the dust layers on the elements to flake off and drop to the bottom. After a few minutes the filter elements are clean and the filter can be taken back into normal operation.



From a paper to the Midland Section, I.G.E., Chesterfield, October 18.

Recent Developments in Gas Compression Plant for Distribution Systems

By R. W. NELSON, B.Sc., M.Inst.Gas E., A.M.I.Mech.E.,
DIVISIONAL DISTRIBUTING ENGINEER, BIRMINGHAM DIVISION,
WEST MIDLANDS GAS BOARD.

THE gas industry is essentially a low pressure industry, although the advent of Lurgi gas will give rise to new ideas in transmission, and relatively small diameter mains working at very high pressures could well become commonplace in future schemes. Currently, however, one thinks in terms of high pressure gas when dealing with transmission pressures of around 20-30 lb. per sq. in. Between these figures and the low pressure systems working at only a few inches water gauge, one encounters a wide variety of operating conditions.

The situation in the Birmingham Division at the present time is as follows:—

	Operating pressure	Over maximum hour	Over day
Gas distributed by:			
Low pressure system ...	5 in - 7 in. w.g.	15%	65%
Booster main system ...	15 in.-100 in. w.g.	34%	25%
High pressure system ...	10-20 lb. per sq in.	51%	10%

While one cannot regard these proportions as typical, throughout the industry the greater proportion of gas dealt with is at relatively low pressure and it follows automatically that the centrifugal fan has, therefore, a tremendous part to play in the distribution of town gas.

The centrifugal fan is universally recognised as a well proven piece of machinery, and I have summarised below those features of it which are particularly acceptable. Although it is frequently an obvious choice for low pressure duties, it is also suitable in both the booster pressure field and for certain applications in the transmission of gas by high pressure.

(1) It is a non-positive machine, that is, it will run without serious build-up of pressure against a closed valve.

(2) There is no need for internal lubrication and no question, therefore, of contaminating the gas.

(3) The machine is a fast running unit and is thus suitable for direct coupling to steam turbine or electric motor.

(4) For a given horse power it is a far less bulky piece of equipment than the reciprocating compressor.

(5) There are no valves and the machine is, therefore, simplified mechanically.

(6) Operating clearances are usually quite large and over prolonged periods of running no noticeable falling off in efficiency is experienced.

A typical pressure-volume curve for a centrifugal machine, upon which has been superimposed a power consumption curve, is shown in Fig. 1. The surge line should be noted, for at

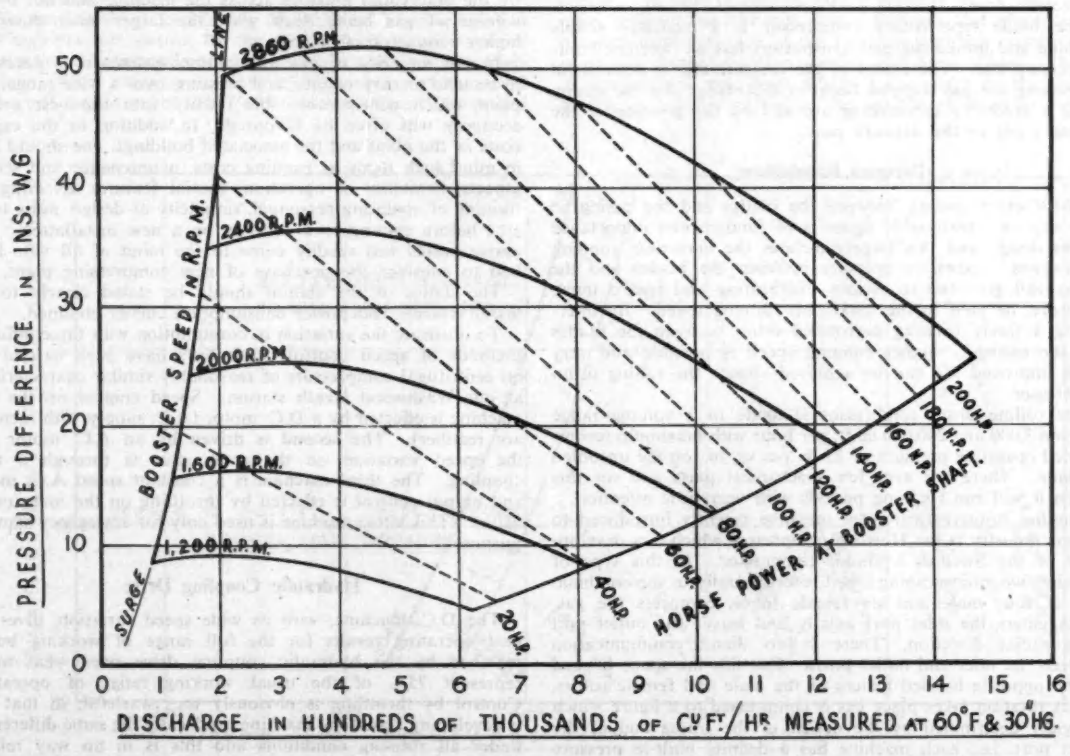


Fig. 1. Characteristic pressure-volume curve for a single stage fan, upon which has been superimposed a power consumption curve.

running conditions to the left of this, heavy fluctuations in operating pressure are likely. Where the design characteristics of the machine are truly related to actual operating conditions, it is possible to shut down the compressor and deal with demands direct from the holder before running into this surge region. Where this does not apply, a by-pass should be incorporated in the installation which is to come into operation whenever conditions approach the surge line. By-pass control is, of course, wasteful in terms of power supply and should only be resorted to in order to free the booster from surge operation.

Where lubricating oil pumps are gear driven, gas should not be sent through a booster which is shut down, for serious bearing problems can result from the slow rotation of the impeller when gas is being passed through it.

Manufacturers rarely exceed a pressure rise of 4 lb. per sq. in. in one stage and the economic limits of compression in the centrifugal machine seem to be about 15-20 lb. per sq. in. Series boosting, usually with inter-cooling, is, of course, possible, but there are few examples of this in the gas industry. The feature limiting the design of the centrifugal machine is primarily the peripheral speed of the impeller, which with the most common design of impeller, is about 800 ft. per second.

It will be appreciated that the usual distributing station operates on a basis of pressure rather than volume control, the aim being to provide a terminal pressure at the most remote distributing point which is just in excess of the minimum inlet pressure to operate satisfactorily a district governor. On a high pressure distributing system one would usually work to terminal pressures of not less than 1 lb. per sq. in.—on a booster main system not less than 12 in. water gauge.

Engineers are familiar with the Roots and Connersville compressors. They are twin-rotor machines and vary only in the disposition of the inlet and outlet gas ports. Essentially slow running, they are nevertheless capable of handling large volumes of gas at operating pressures of up to 10 lb. per sq. in. (or higher in the water cooled machines). These machines are actually transporters that is, there is no inherent built-in pressure rise within the compressor. The characteristics of the outlet mains system in relation to the volume being handled determines the delivery pressure on the outlet. The machine is positive and the delivery somewhat pulsating in character.

The blade type rotary compressor is a basically simple machine and unlike the gas transporters has an inherent built-in pressure rise. The extent of the pressure rise is determined by moving the gas trapped between the blades and the casing along a gradually diminishing arc and by the position of the release point in the delivery port.

Dictates Revolutions

Satisfactory sealing between the blades and the casing to keep slip to a reasonable figure is of fundamental importance in this design and this largely dictates the maximum running revolutions. Excessive pressure between the blades and the casing will give rise to serious overheating and regard must, therefore, be paid to the maximum running speed. By interposing a freely rotating perforated drum between the blades and the casing, a higher running speed is possible and very much improved life can be achieved—hence the rolling drum compressor.

The rolling drum compressor is made in a volume range between 3,000 and 200,000 cu.ft. per hour with maximum recommended operating pressure of 15 lb. per sq. in., on the uncooled machine. There are very few mechanical parts and for this reason it will run for long periods with very little attention.

Another positive twin rotor machine recently introduced to the gas industry is the Howden compressor which is a development of the Swedish Lysholm compressor. In this type of machine two inter-meshing lobed rotors, usually in the combination of four male and six female lobes, compress the gas, which enters the inlet port axially and leaves the outlet port in a radial direction. There is no direct communication between the inlet and outlet ports. Gas fills the space formed by the opposite handed helices of the male and female rotors, and as rotation takes place gas is compressed to a figure which is rigidly determined by the design of the rotors and of the outlet port, i.e., each machine has a definite built-in pressure rise. For maximum efficiency one should aim to run the machine near the design point, although over a limited pressure

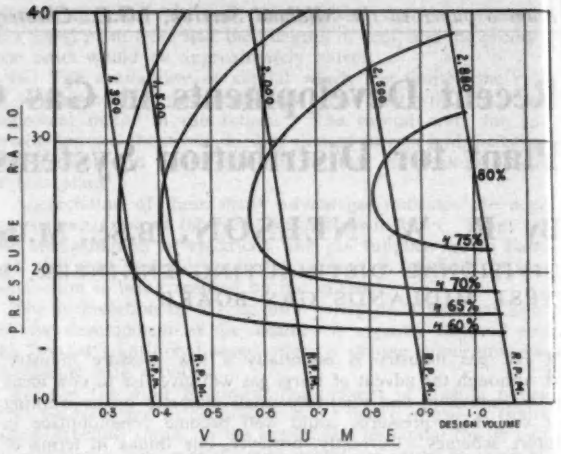


Fig. 2. Characteristic pressure ratio-volume curve for a Howden compressor.

range on either side of this there is only a small reduction in efficiency. Correct relationship of male and female rotors is maintained by timing gears; the power absorbed by these gears is less than 5% of the input power to the compressor.

Up to a pressure ratio of about 6:1 the Howden compressor is available as a single stage machine and is usually uncooled up to a pressure ratio of 2:1. As a two-stage machine (either in series or as a tandem layout) the compressor can operate with pressure ratios of up to 10:1.

Typical characteristics of the Howden compressor, based upon a built-in pressure rise of 2.7, are shown in Fig. 2. It will be seen that at the design point the adiabatic efficiency is of the order of 80%. Being positive in action, the free volume handled varies directly with the running speed of the compressor. The Howden compressor is inherently a surge-free machine. Since the degree of leakage is largely determined by the differential pressure across the machine and not by the volume of gas being dealt with, the larger units show the higher volumetric efficiencies.

In the majority of gas distribution systems it is necessary to be able to vary volume and pressure over a wide range, and plant which will provide this facility with the best overall economy will often be favoured. In addition to the capital costs of the plant and the associated buildings, one should bear in mind such items as running costs, maintenance and service aspects, flexibility of operation, special features involving the training of operating personnel, simplicity of design, noise level, etc., before coming to a decision on a new installation. The above points will readily come to the mind of all who have had to consider the purchase of new compressing plant.

The duties of the station should be stated clearly to the manufacturers and power consumption curves obtained.

To illustrate the variation in consumption with three different methods of speed control, some tests have been carried out on centrifugal compressors of reasonably similar characteristics at our Washwood Heath station. Speed control on the first machine is effected by a D.C. motor (A.C. supply with mercury arc rectifier). The second is driven by an A.C. motor and the speed variation on the compressor is through a fluid coupling. The third machine is a constant speed A.C. motor and output control is effected by throttling on the main outlet valve. (This latter machine is used only for emergency standby purposes.)

Hydraulic Coupling Drive

The D.C. machine, with its wide speed variation, gives the best operating results for the full range of working but is matched by the hydraulic coupling drive over what might represent 75% of the usual working range of operation. Control by throttling is obviously very wasteful, in that one is developing across the machine practically the same differential under all running conditions and this is in no way related to the desired pressure conditions in the outlet main.

In terms of simplicity of installation and overall economy of

operation, there is frequently a very strong case for the squirrel cage induction motor with a fluid drive.

In this Division the fluid drive has been used extensively both in the form of a traction coupling and as a scoop controlled coupling for purposes of speed variation. As a distribution department we are primarily concerned with its use as a means of varying the output over the usual working range encountered on the distribution system. The fluid drive can, of course, effect infinite variation of output speed, provided there is an adequate cooling system for the oil in the working circuit. Such facility is, however, of little value on the average distribution system. The efficiency of transmission across the coupling is in direct relationship to the ratio of the output to the input speed. The maximum power lost in transmission (and representing about 16% of the full load power requirements) occurs at a coupling output speed of two-thirds the motor speed.

The effectiveness of the coupling as a means of speed variation is largely determined by the characteristics of the machine being driven. It is worth while, therefore, to examine thoroughly the likely operating conditions at the booster, so that the coupling losses can be fully appreciated; only then can one truly establish the suitability of the fluid drive as a means of speed control.

Effectiveness Altered

By varying the amount of fluid in the working circuit, the effectiveness of transmission across the coupling is altered. Full transmission entails the maximum quantity of oil in the circuit. Similarly, the maximum speed ratios occur when there is the minimum amount of oil in the working circuit. The amount of oil in circulation can be controlled by a scoop tube, which can be positioned manually, automatically or by remote control. The oil for the coupling and for the coupling bearings is usually contained in the baseplate on which the coupling and its oil coolers are mounted, so that the whole thing is a self-contained unit.

The main benefit of the fluid drive when starting up the induction motor is that the motor can be brought up to speed far more quickly, so that the period during which the supply mains are subjected to a high starting current can be very much reduced.

We were faced recently with the problem of developing a new high pressure station, for the existing high pressure system, in terms of capacity and operating pressure, was becoming overloaded. Total plant availability at the existing station is 2 mill. cu.ft. per hour; of this 750,000 cu.ft. per hour is supplied by three steam driven reciprocating compressors (which maintain their efficiency over a wide range of operating conditions), and the remainder by two centrifugal compressors, one steam turbine driven and the other electrically driven.

It was felt that there would be some advantage in supplying the high pressure system from two independent sources—hence the decision to build a completely new station at Washwood Heath.

The high pressure mains emanating from this station would merge with the existing system from our Windsor Street works and would thus permit adjustment of flow between the two stations.

Peak Efficiency

Reciprocating plant already available at Windsor Street could deal with the lower range of operating requirements and having regard to this, it was possible to select for the new station, plant possessing an inherently high efficiency of compression. Operating conditions would be so scheduled to ensure that the new plant always ran at or near peak efficiency.

Consideration was given to a number of alternative designs, capable of dealing with a maximum of 600,000 cu.ft. per hour at 25 lb. per sq. in. gauge pressure and it was intended that eventually three units of this capacity would be installed.

Our attention was drawn by the Board's Mechanical and Electrical Engineer, Mr. G. M. Rimmer, to the axial flow compressor, hitherto unused in the field of town gas compression, and eventually it was decided to purchase one of these machines. The high running speed of 19,000 r.p.m. and the high gas velocity through the machine, result in a compressor of very compact overall dimensions. In this machine the gas enters the blading section via an annulus, the design of which is such that the gas accelerates towards the first row of blading—a static row which is known as the prewhirler. The gas enters this row at approximately 450 ft. per second and this axial velocity of flow is maintained throughout the blading section of the compressor. There are 14 stages in the compressor, each stage comprising one moving and one fixed row of blades. Briefly, the peripheral velocity of the gas leaving the moving row of blades is destroyed in the fixed blading and the loss of kinetic energy is replaced by a rise in pressure energy. In this design an equal pressure ratio, that is the ratio between the absolute outlet pressure and absolute inlet pressure occurs in each of the 14 stages and this pressure ratio is equally divided between moving and fixed blades. The rise in temperature per stage which takes place in the moving blades, is directly related to the peripheral speed of rotation

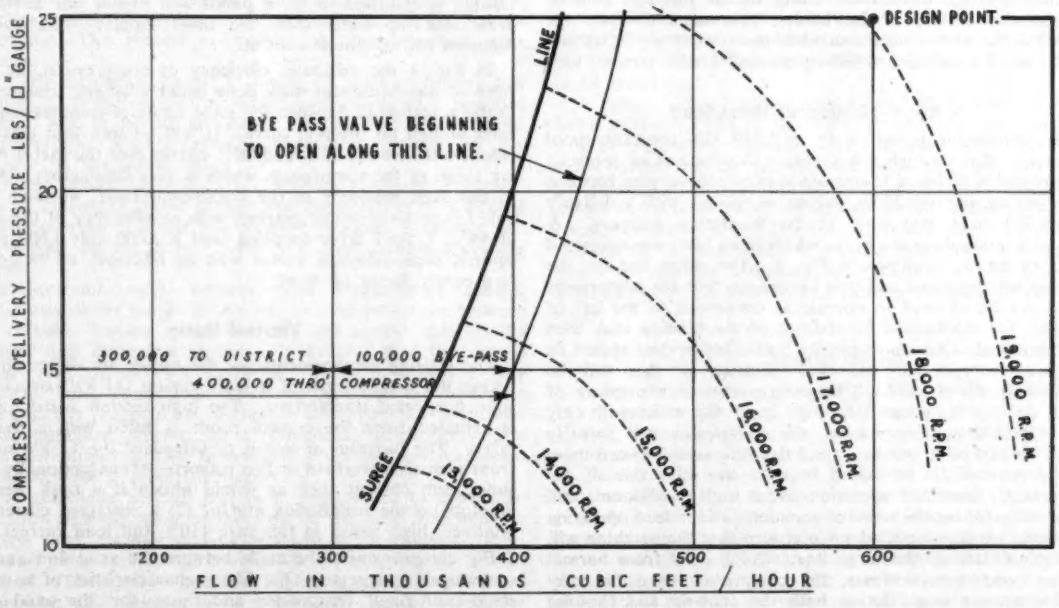


Fig. 3. Characteristic pressure-volume curves at varying revolutions for an axial flow compressor.

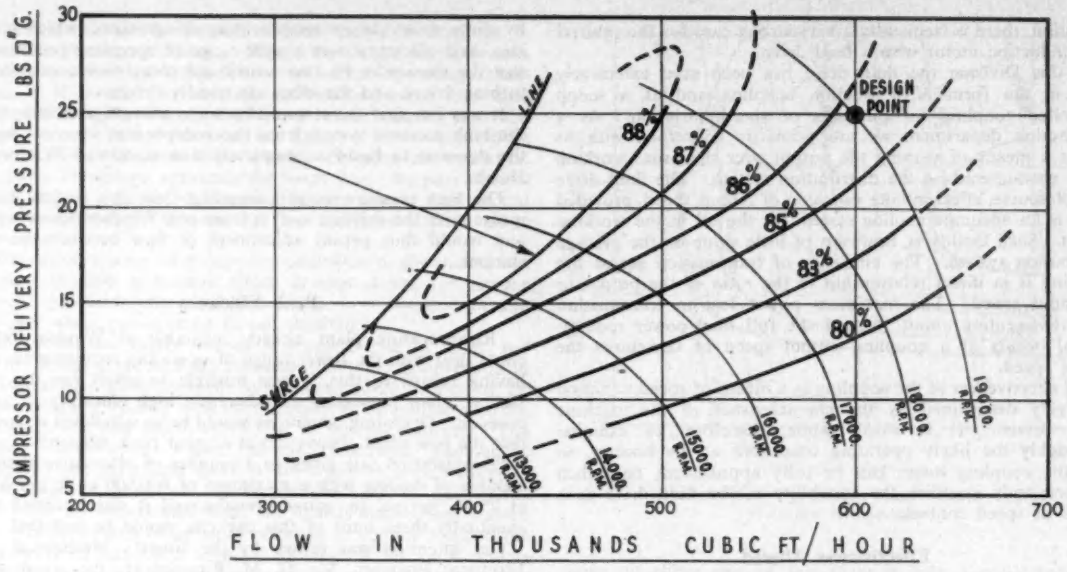


Fig. 4. Pressure-flow curves, upon which have been super-imposed adiabatic efficiency curves.

and as this varies only slightly along the whole length of the rotor, the temperature rise in each stage is about the same. The actual rise in temperature per stage under maximum load conditions is approximately 8°C. It follows too that, as the work done per stage is proportional to the mass gas flow and the rise in temperature, the work done per stage is approximately the same for all 14 stages. The final row of blades at the exit end of the compressor serves to straighten the direction of flow so that gas leaves this row axially. The gas then enters the diffuser where its velocity is reduced and a rise in pressure takes place. Experience has shown that by keeping the axial velocity at about 450 ft. per second, a reasonable kinetic/pressure energy conversion can be effected in the diffuser. In fact, a rise of pressure of about 1 lb. per sq. in. takes place.

Blade clearance is of fundamental importance. On this machine the minimum axial clearance is of the order of 35/1,000ths in. and the tip and root clearance 15/1,000ths in.

On the maintenance of these blade clearances, the operating efficiency and the mechanical safety of the machine depend. To minimise fouling of the blades, benzene and water are injected at the end of each run while the compressor is coming to rest, usually between 6,000 r.p.m. and 1,000 r.p.m.

To Avoid Mechanical Breakdown

The compressor is driven by a 1,150 H.P. constant speed induction motor through a hydraulic coupling and an epicyclic gearbox and is designed to operate at pressures varying between 7½ lb. per sq. in. and 25 lb. per sq. in. gauge, with a delivery of 600,000 cu.ft. per hour at the maximum pressure. A pressure/volume diagram, upon which have been superimposed curves of r.p.m., is shown in Fig. 3. The surge line for the machine will be noted and it is imperative that the compressor should not be allowed to operate at conditions to the left of this line, for mechanical breakdown of the blading may then be experienced. An automatically controlled by-pass system is, therefore, incorporated and the operation of this will be described in detail later. This ensures that at a pressure of 15 lb. per sq. in. gauge (see Fig. 3), if the main will only accept 300,000 cu.ft. per hour, the compressor will actually handle 400,000 cu.ft. per hour, and the difference between these two figures will be by-passed back to the inlet side of the compressor. Sustained operation under such conditions could not be tolerated on the score of economy, and indeed operating conditions are so scheduled as to ensure that the machine will be running clear of the surge line. Quite apart from normal running conditions, however, the compressor must be safeguarded against surge during both the start-up and shutting down of the machine.

The compressor delivery pressure is maintained at any desired value by the operation of the scoop control hydraulic coupling. The design provides for automatic control of this coupling but the scoop tube can, of course, also be operated manually. A non-return valve, situated in the outlet main, is linked to an emergency by-pass valve, so that in the event of the non-return valve closing, the emergency by-pass is tripped open and the whole of the gas handled through the compressor is by-passed back to the inlet main. The emergency by-pass valve can also be used as a hand-operated by-pass valve.

Cooling of the main motor and the purging by air of a number of instrument panels on the main compressor floor, is effected by fan units drawing air from outside the building. Air is fed to the main motor before it is started up. Cooling water for the main gas coolers, and for the auxiliary oil coolers which are located on the baseplate of the compressor, is supplied from centrifugal pumps working in conjunction with cooling towers of conventional design. Cooling water, which would otherwise run to waste from a neighbouring booster station, is returned to these ponds and avoids our having to draw make-up water from the town supply. The plant is designed for automatic control.

In Fig. 4 the adiabatic efficiency of compression, i.e., the ratio of the theoretical work done under adiabatic compression to the actual work between the same limits of compression, has been plotted on the p.v. curve. It will be seen that adiabatic efficiencies between 82% and 88% obtain over the useful working range of the compressor, which is very satisfactory. Allied to this high efficiency of the compressor itself, we have been able to use an epicyclic gearbox with an efficiency of the order of 98%, a fluid drive coupling, and a 3,000 volt 3,000 r.p.m. squirrel cage induction motor with an efficiency of 94%-96%, at a power factor of .9-.91.

Thermal Relay

The starting arrangements for the motor are direct on-line, taking the simple form of a high tension (11 kV) switch and solid connected transformer. The high tension switch, which is actuated from the control room, is fitted with a thermal relay. The function of this is to safeguard the 11 kV supply from excessive overload in two respects—(1) exceptionally high short term current such as would obtain if a fault were to develop on the installation and/or (2) a sustained current of relatively high value, in this case 110% full load current.

For comparisons to be made between the axial flow and the centrifugal compressors, the likely characteristics of a multi-stage centrifugal compressor and those for the axial flow machine have been plotted and are shown in Fig. 5 To

establish the horse power requirements at a certain pressure and volume, the necessary r.p.m. should be obtained from the lower curve. The horse power requirements at the input to the compressor can then be read from the horse power/volume curve. This diagram illustrates a number of important points.

(1) The surge line for the centrifugal compressor is more favourably placed and allows a wider field of operation at all levels of pressure.

(2) At a particular running speed—

(a) With the centrifugal compressor a reduction in volume is accompanied by a rise in pressure and for most of the range of operation a reduction in horse power, whereas

(b) in the case of the axial flow compressor, a more pronounced rise in pressure occurs as the volume reduces and there is an increase in the power absorbed.

(3) With its particularly high efficiency of compression, the power requirements of the axial machine would be less than those for the centrifugal compressor at all normal running conditions lying to the right of the surge line.

The following details of the ancillary plant installed as part of the axial flow compressure are of interest.

Standby Pumps

Duplicate lubricating oil pumps are provided. Before the main motor is started, oil is already being fed to the bearings from the standby pump, which is on an independent circuit. This standby pump is tripped out when the other pump (on the same circuit as the main motor) takes over and will come into action again if, for any reason, the running pump fails. The lubricating oil pump takes oil from the main reservoir base plate of the machine and delivers it from the pumps through a reducing valve and oil cooler to the compressor gear box end motor bearings at 30 lb. per sq. in. and the hydraulic system of the speed control and the gas by-pass control gear at 70 lb. per sq. in. Special attention has been paid to the sealing of the blading section of the compressor from oil leakage, as oil leaking into the inlet end would tend to foul the blading. Weston Impax seals, together with a series of thin metal rings with fine clearance between their inside diameter and the rotor, are fitted at each end of the machine and gas leaking past these seals at the delivery end is bled back to the inlet side. More positive control of both oil and gas leakage has been made possible by introducing a small scavenger pump, which is designed to limit the build-up in pressure in each gland to about 1 in. W.G.

To maintain the compressor outlet pressure constant, the speed of the compressor is varied by the hydraulic coupling, which is working under the influence of the process controller. The process controller has the following main circuits:

(1) The measuring circuit in which the current flowing has a range of 0-30 mA (D.C.), which corresponds to a pressure range of 5-30 lb. per sq. in. gauge. Current flow in this circuit is interpreting what is actually happening in terms of gas pressure in the outlet main.

(2) The desired volume circuit provides a reference current. It is an inherently stable circuit, and the selection of a desired operating value of outlet gas pressure produces a definite and unchanging current flow. There is a neon stabilised voltage source.

(3) Electronic servo control.—The proportional control circuit establishes the error current, i.e., the difference between the currents flowing in (1) and (2) and applies this to the integral and derivative circuits. It follows that the output signal from the process controller, which is passed to the magnetic head controlling the scoop tube of the hydraulic coupling, has proportional, derivative and integral content and it is, therefore, known as a three-term controller. The controller output is used to energise a moving coil suspended in the field of a powerful magnet.

The automatic by-pass gear is so designed as to come into operation at some point to the right of the surge line and the by-pass valve assumes varying positions in its length of travel between zero and 100% by-pass flow, according to district demand. The need to use this facility is normally restricted to start-up and shutting down procedure. Again, a jet pipe controller, fed with oil at 70 lb. per sq. in., is used, but in

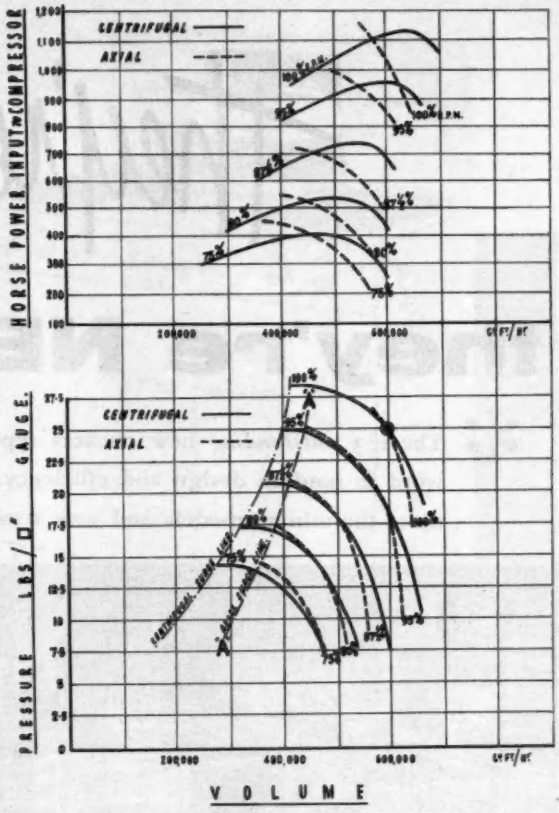


Fig. 5. Curves showing a comparison between axial flow and centrifugal compressors.

this instance, the jet pipe comes under the influence of forces derived from, (1) the pressure at outlet compressor, (2) the flow to the inlet compressor, (3) the flow in the by-pass main.

The oil issuing under pressure from the jet pipe impinges upon a surface at right angles to the direction of flow. In this surface plate (or distributor) are two orifice plates which are connected by pipework to the opposite sides of a piston, which in turn is mechanically linked to the gas by-pass valve. Movement of this jet pipe establishes a new set of conditions at the piston, which assumes another position and so alters the position of the valve and consequently the amount of gas to be by-passed.

A failure of oil supply will bring into action the cut-off valve in the oil line to the scoop control and the scoop tube will be locked in position. At the same time the by-pass valve in the oil line cylinder controlling the position of the gas by-pass valve will operate, and the pressures will equalise across the piston. Out of balance forces in the form of the counterweight on the cylinder crank lever and of the gas pressure on the by-pass valve, will cause this valve to swing fully open, so ensuring complete re-circulation of the gas being handled by the compressor and thereby avoiding a tendency to surge.

Assured Supply

Unless there is some physical blockage in the oil line from the pumps, the supply of oil to the bearings is assured, because loss of power supply to the running oil pump brings in the standby pump when the bearing pressure falls to 25 lb. per sq. in., and the bearings are properly served with oil while the machine comes to rest. Under normal shutting down procedure the compressor speed is reduced to about 6,000 r.p.m., at which speed the scoop tube has reached its maximum travel and the main motor (and automatically the main oil pump) is then shut off. The compressor comes to rest in about three minutes, the motor about five minutes later.

If the compressor is running and neither the main oil pump

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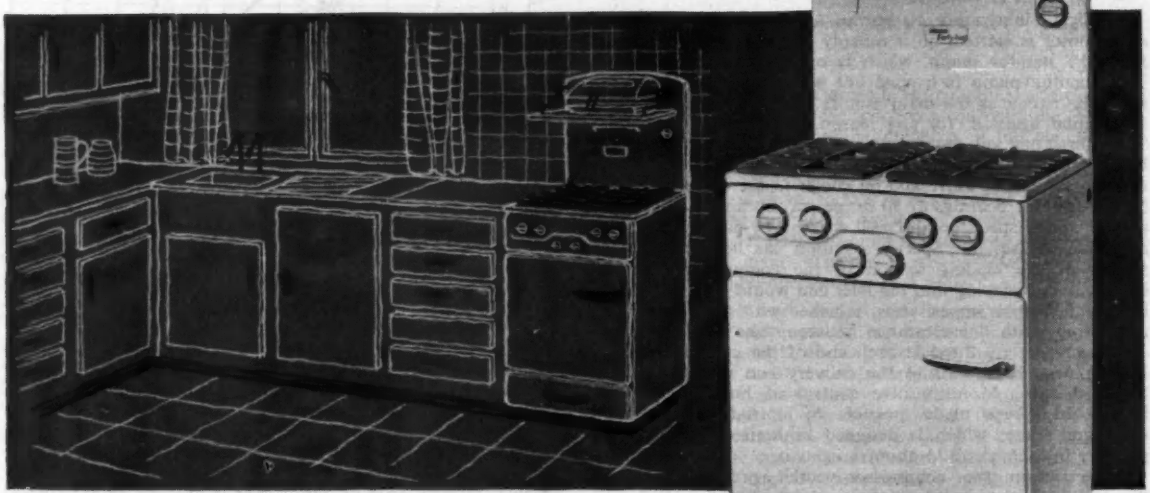

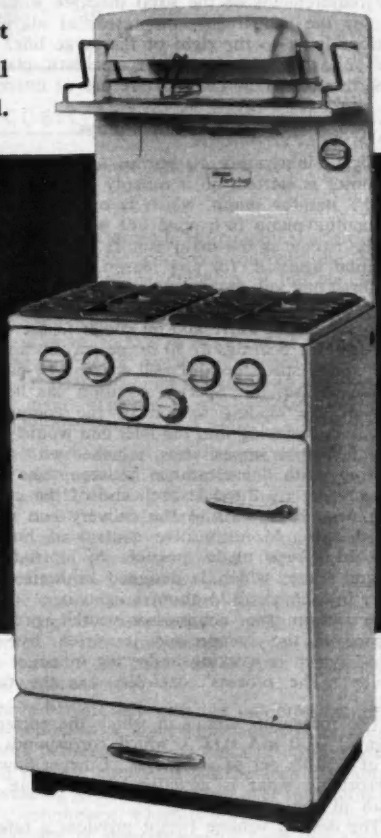

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nor the standby pump can maintain an adequate oil pressure, the machine will be shut down when the oil pressure at the bearings falls to 23 lb. per sq. in.

DISCUSSION

In reply to a written contribution by **Mr. G. le B. Diamond,** Chairman of the West Midlands Gas Board, **Mr. Nelson** stated that he had greatly appreciated the interest his Chairman had shown regarding the axial flow project, and his written comments were a valuable contribution. He had refrained from quoting capital costs, since the application of the axial flow machine to gas compression had been something new to both the Board and to the manufacturers and was not a standard manufacturing line. It was a fact, however, that as an installation, the axial flow machine had proved attractive financially, comparative centrifugal units being between 10% and 30%, and reciprocating machines about 60%, more expensive. He agreed that wherever electronic control was installed the speedy replacement of faulty parts was essential, and the equipment described did in fact lend itself to this facility.

Mr. S. K. Hawthorne, Divisional Engineer, Birmingham, referred to the load factor on high pressure systems and the very pronounced impact of maximum demand charges on running costs. Did Mr. Nelson feel that there would have been any merit in having the plant diesel driven?

Mr. Nelson said that on any high pressure system dealing directly with consumer network, a high load factor could not be achieved overall. At the present time on the existing high pressure system the load factor was something less than 20%. The axial flow machines, which would perform very efficiently over a useful range of operating conditions, would be used to maximum advantage, and he hoped that over 16 hours a day they would have an exceptionally high load factor while at work and a very reasonable one overall. Consideration had been given to a diesel driven unit, and he had calculated that overall pumping costs at the station would be about .59d. per therm with an electric drive and about .62d. per therm with diesel driven units.

Mr. F. H. Bate, Divisional Engineer, Wolverhampton Division, referring to the running hours before maintenance, quoted a figure of 2,000 hours for diesel driven units they had installed.

Mr. Nelson said that some 3,000-4,000 hours was usually considered an average period of running before diesel overhaul—in the case of the axial flow machine they hoped that it would not require to be overhauled more frequently than after every 7,000-8,000 hours running.

Mr. Hawkings, Divisional Distributing Engineer, Warwickshire Division, referred to the advisability of having several units of varying capacity rather than to attempt speed control with a large unit over a wide range.

Mr. Nelson agreed that there was a case for this and suggested that that was indeed what they were doing. The axial flow installation could not be regarded as an isolated unit. It was in fact only part of a large high pressure compressing system where they already had several smaller capacity units and a multiplicity of drives which permitted selective running.

Mr. Hawkings asked for further information on the vibration measuring equipment and whether there could be any sudden deterioration in the set which could result in disintegration without adequate warning being given.

Mr. Nelson replied that the vibration measuring equipment was of Philips' design, which consisted of an electro dynamic detector which translated measured velocity of vibration at the most susceptible part of the compressor into a pulsating voltage, which is in turn amplified and displayed in terms of amplitude on a L.F. amplifier volt meter. The extent of vibration from the machine was of a particularly low order. The most likely cause of trouble lay in the deterioration of working clearances within the compressor itself. As they were logging considerable data at half-hour intervals, and blade fouling would be reflected in the performance of the compressor, he felt that suitable safeguarding action could be taken.

Mr. G. M. Rimmer, Electrical and Mechanical Engineer to the West Midlands Gas Board, in a written contribution, said that he had constantly striven over many years to produce the most economic type of drive. Referring to the built-in pressure rise, he said that the waste of power was halved by the expansion of the gas down to outlet mains pressure. The compressors selected for the comparison of the various types of speed control had not in fact similar characteristics and the diagrams were really only helpful to the extent of showing the relative dispersion of the curves, but he stressed the advisability of investigating the characteristics of the system in relation to those of the machine before selecting speed control equipment. Dealing with the axial flow machine, he said that the adiabatic efficiency was in fact a relative term which had no absolute meaning unless the conditions were clearly defined, but the input power was the true criterion of the compressor performance. He mentioned that surge characteristics applied to motors as well as compressors and that this had proved a problem on some installations.

In reply, **Mr. Nelson** said that he would like to pay tribute to the very considerable assistance he had received from Mr. Rimmer in connection with the axial flow machine.

Although the compressors selected to illustrate various means of speed control were of the centrifugal type, they were not identical. They had, however, served to illustrate the relative dispersion of the curves to which Mr. Rimmer had referred. No term was perhaps used more loosely than 'efficiency.' Adiabatic efficiency was sometimes used to relate the true work done on the gas within the compressor to that which would have applied had the compressor been performing adiabatically between the same limits of pressure. Such a comparison is referred to frequently as the adiabatic temperature efficiency, or in some compressors as the blading efficiency. The figures quoted for the axial flow compressor are on this basis. The term 'overall adiabatic efficiency,' in which adiabatic work is related to the actual input horse power to the compressor is also used.

'Vacation Training'

A BOOKLET, 'Vacation Training', has been published by the Imperial College of Science and Technology describing the results achieved over the past ten years by the International Association for the Exchange of Students for Technical Experience (IAESTE). The Imperial College vacation work scheme, sponsored by the College and the Students' Union, exists to provide undergraduates with practical experience of industrial conditions at home and abroad during vacations. The Committee is affiliated to IAESTE, which grew up from the nucleus of the Imperial College organisation.

The relations of the Imperial College with industry have always been close as was intended by those who drafted the Charter of the College providing for a number of professional bodies to be represented on the Governing body. In this way a close link with industry was forged at the outset, and developments over the years have made it stronger than ever. There are also industrial representatives on the special committees which advise the Governing body from time to time on particular aspects of its advanced technological work. Members of the teaching staff are encouraged to maintain their contacts with industry and with the professional and learned societies, while the advanced technological courses which are a special feature of the work of the College are increasingly welcomed by industry.

The handbook, 'Vacation Training', is a first issue and it is hoped that it will result in many more British industries considering the possibility of accepting both students of Imperial College as well as students from abroad for industrial, commercial, and agricultural training during the long vacation.

Checking Old People's Appliances

THE Eastern Gas Board at Luton is compiling a list of old people who use gas appliances and who live alone. Every three months gas officials will visit the old people and check their appliances to make sure they are safe. Adjustments to ensure greater safety are also being made. An official said: 'We are making sure that the meter is at a suitable height. Accidents often happen when old people climb on chairs to reach things, and we do not want them to do that to get to the meter.'

From a paper to the Eastern Junior Gas Association, October 28, 1957.

The Production and Use of Ammoniacal Liquor as a Nitrogenous Fertiliser

By W. W. LAW,
MANAGING DIRECTOR, NITROGEN APPLICATION LTD.

WHEN a farmer applies nitrogen to a crop, he can apply it in two different forms—first, as a nitrate in which case the plant can absorb it as a food immediately, or as an ammonium compound which first has to be nitrified before it can become available to a plant. Normally, this takes from ten to fourteen days to be performed by the active soil micro-organisms. When using ammoniacal liquor as a source of nitrogen, the farmer is purchasing an ammonium compound, so that he will normally expect to see results from ten to fourteen days after an application.

How then can we persuade the farmer to use ammoniacal liquor as a source of nitrogen and how can we assist him in obtaining the desired results? In common with other suppliers of nitrogenous fertilisers we must provide sound technical advice on the practical application of the liquor to convince the farmer on the following points: The results compare very favourably with those obtained from the more conventional types of nitrogenous fertilisers; the liquor is readily available; application is speedy; storage space at farms is not required; rain is not required after application to make it effective; liquor is not leached out of the soil by winter rains; repeated dressings tend to eradicate weeds; some control of liver fluke and husk organisms and pests such as slugs is obtained; ammoniacal liquor is alkaline and does not rob the soil of lime; and the overall application is cheaper by comparison with other nitrogenous fertilisers.

If we can persuade farmers that these statements are true, there seems no doubt that they will prefer to use this source of nitrogen, but are these statements true? I personally think that they are. Many of you no doubt are familiar with the article published a short time ago in the 'GAS JOURNAL' giving results of experiments with gas liquor compared with equivalent dressings of sulphate of ammonia. The results, briefly, were that under most circumstances, ammoniacal liquor was from 60% to 75% as efficient as equivalent dressings of sulphate of ammonia on grassland. Not very encouraging figures! But do we accept those figures as being a true representation of the efficiency of ammoniacal liquor?

Taking a closer look at the figures, we find that when ammoniacal liquor was applied on to prepared seed beds for use by arable crops, in this particular case a kale crop, it gave at least the same results as equivalent dressings of sulphate of ammonia.

Similar Results to Sulphate of Ammonia

Does the answer lie here? I think it does. In these cases, the ammonium compounds entered the soil directly and were all available for subsequent nitrification. The ammonia in gas liquor cannot be any the less effective than ammonia in the form of sulphate of ammonia because it is derived from the same source—coal. There is a good reason why gas liquor might be slightly more efficient than sulphate of ammonia when used on arable crops. It enters the soil in liquid form immediately; base exchange takes place between the ammonia compounds and the clay fraction in the soil. Surrounding the clay fraction in the soil are soil colloids. These small soil particles have a great affinity for water. A theory expressed is that these colloids attract the liquid ammonia and hold it near to the clay fraction so that the ammonia is rapidly fixed in the soil by base exchange. It might only make a very small amount of difference, but the possibility is there.

What then went wrong with the experiments which were done on behalf of the indusrty? From conversations I have had with the people responsible for the experiments, I found that the liquor used was taken from various works up and down the country. I am assured that the liquor was of 10 oz. strength, but I am equally convinced that no works in this counry with either horizontal or vertical retorts is producing liquor suitable for use immediately as a fertiliser without first modifying plant to obtain the required strength and purity.

If the liquors were found suitable for use immediately as a fertiliser and of 10 oz. strength, the practice adopted was to fill 5 or 40 gall. drums, take the liquor away and apply it to the experimental patches. I was informed by the people responsible for these experiments that the liquor used was not as clear as liquor we were demonstrating at the Great Yorkshire Show. In fact, they said that the liquor when applied contained tar particles and light tar oils. Changes undoubtedly take place during the time the liquor is in contact with metal drums.

The suggestions offered to me by the experimental officers for the lower efficiency of ammoniacal liquor compared with sulphate of ammonia when used on grassland were, scorch, which was excessive and prolonged, evaporation, and volatilization.

Evaporation could only be small unless the liquor became mechanically attached to the herbage for any length of time. This would only happen in a prolonged dry spell of weather, in which case, some losses would be experienced with dressings of other sources of nitrogen.

With regard to losses by volatilization, we are at present carrying out experiments blowing air through liquor, and we are finding it extremely difficult to displace ammonia. We are convinced that even on very windy days, losses by volatilization during application can only be very small indeed, so that it would seem the apparent loss in efficiency was due to the scorching of herbage.

Liquor Quality

The liquor before use should be clear, straw coloured, free from light tar oils and from suspended tar particles which are known to be responsible for prolonged and excessive scorch.

No oxidation of the liquor should be allowed to take place during its manufacture. On most large works, air is pumped into the gas at the entrance to purifiers. This generally is satisfactory. If air is drawn into the system at the entrance to the condensers, an oxidised liquor is obtained which is not suitable for use as a top dressing on grassland. When applying the oxidised liquor as a top dressing, the scorch is more excessive and prolonged than if the liquor oxidises after it is applied to the land. We paint the inside of our delivery and spreading tanks with an anti-corrosion paint and never, in any circumstances, allow an oxidised liquor to go on to the land as a top dressing.

We can now see how a prolonged and excessive scorch was obtained on the trial plots. With a suitable liquor, correct equipment and with adequate control over the method of application at the correct stage of growth on grassland, scorch can be almost non-existent.

The percentage of phenol should be kept as low as possible. Generally, the percentage is about the same on most works carbonising in continuous vertical retorts. It is only when dealing with liquors particularly from low-temperature carbonisation plants that we expected very much higher percentages of phenol.

These liquors applied under unfavourable weather conditions can cause prolonged and severe scorch, amounting almost to the killing of the crop. It must be remembered, however, that liquors from low-temperature coal carbonisation plants contain

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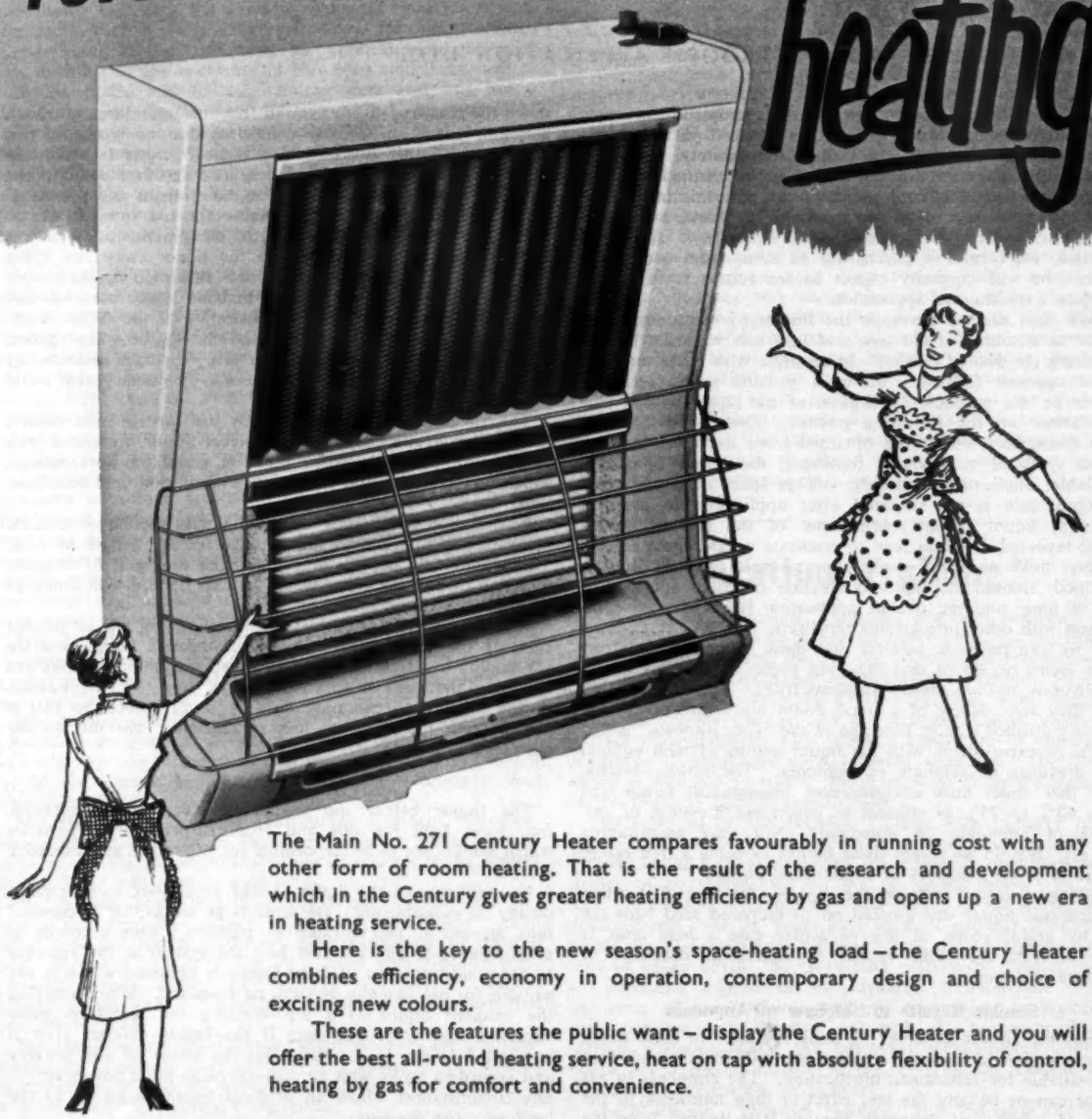

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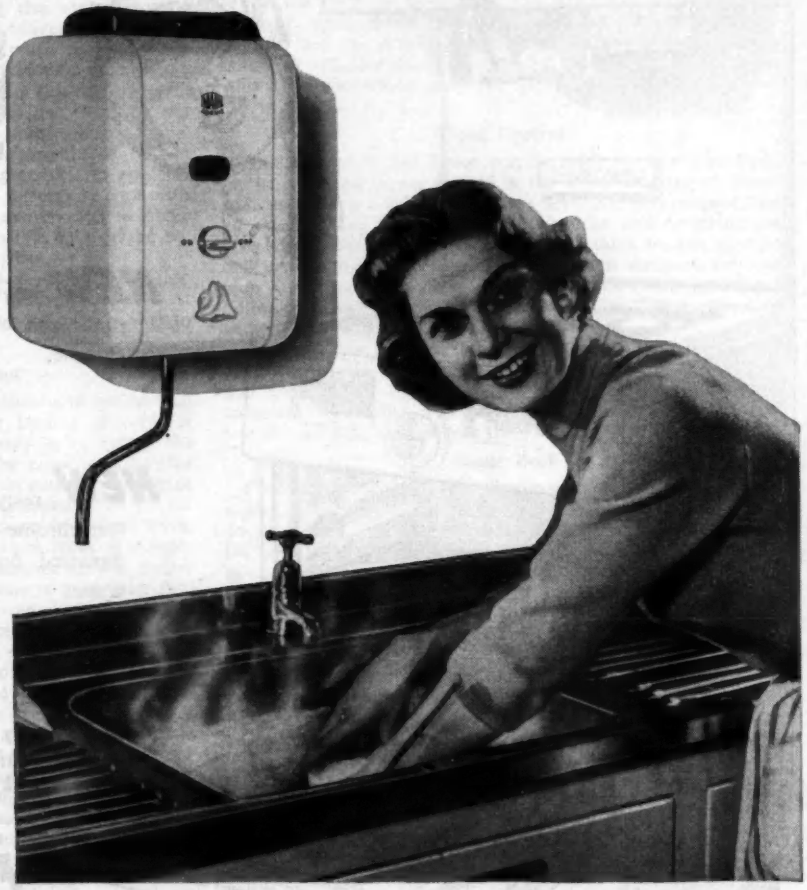

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larger percentages of fixed ammonium compounds, contain no ammonium polysulphides and are likely to give excellent results in cold damp weather.

Liquor Strength

Ammoniacal liquor should be of 10 oz. strength for use as a fertiliser. This is important because if the liquor is below this strength, it is not economic for a contractor to handle it on its nitrogen value.

The composition of liquors can vary, and the practice of adding ammonium hydroxide to well liquor to bring up the strength to 10 oz. should be discouraged, as it is almost certain that the majority of this added liquor is lost during application.

Concentrated ammoniacal liquor has its uses, but definitely not for topping up the strength of well liquors. Fixed ammonium compounds should be at least 40% to 50% of the total ammonia present. The liquor we are handling at Lincoln is normally about 1% fixed ammonia out of a total ammonia content of 1.8%. It is possible to get a 10 oz. liquor of this quality on any works.

Marketing and Distribution

A marketing problem is created by the fact that larger amounts of liquor are produced during the winter months when there is little or no demand for the conventional sources of nitrogen; and production is so very much smaller when demand by farmers is at its peak. There is not enough storage space available on works to store liquor from this peak production during the winter months in order to use it during the spring and summer when it is normally required on farms. Fortunately, liquor has properties which recommend its use during winter. This is a departure from general farm practice, but it is an idea which we have to sell to farmers to cope with this increased supply during the winter months and in order to keep our own overheads as low as possible by working for as many months of the year as we possibly can.

This, however, gives us the added problem of the application of liquor when the land will not carry heavy vehicles. At such times we must use smaller spreading vehicles of 400 to 500 gal. capacity.

Grassland Management

Farmers are now realising that the cheapest and easiest way of reducing the high cost of the winter feeding of cattle is by managing their grassland in such a way as to extend the period of grazing during the year, and by conserving surplus grass to give them a produce which can, in some part, replace costly protein in their winter feeding programme.

The farmer can prolong his grazing season in several ways, the principal ones being the use of the right types of grasses in short leys, as some of the grasses commence growth earlier in the spring than others, and some continue to grow later into the autumn. These grasses can be made more productive and more nutritive by the correct use of nitrogenous fertilisers. To date, ammoniacal liquor has proved itself to be an ideal source of nitrogen for this purpose. Applications of liquor to suitable swards after growth has stopped in the autumn produces a flush of high protein grass in the early spring—a condition very welcome indeed to farmers with milking cattle or early lambed ewes. Providing that the ammoniacal liquor is applied to the land, after the soil temperature has dropped below 40°F., no nitrification of the ammonia will take place until the soil temperature again rises to over 40°F. in the early spring. This could happen on some types of soil before many farmers can get on to the land to spread the conventional types of nitrogenous fertilisers.

If this one simple rule is observed, loss of ammonia by leaching is never likely to exceed 10% of the total ammonia applied. Applications of ammoniacal liquor can be made to grassland throughout the growing season and into the early autumn, still showing an economic return to the farmer.

Before making any application of liquor to grassland, it does pay to examine the sward closely. Most permanent pastures contain very poor species of grass, and generally, applications of liquor can be disappointing. We like to confine applications to short leys, as they generally are in good heart and respond readily to nitrogen.

Before any applications are made to grassland, the field should always be inspected. Weeds such as sorrels, spurrey, and pennycress indicate that a field is short of lime. Base exchange takes place very slowly in a field of a low pH value. Again, if the clover looks weak and is patchy in appearance it may well be that the field is short of phosphates. Full efficiency cannot be obtained from nitrogen, whatever its source, if there is a deficiency of one or other basic fertilisers.

Field weeds give an indication of poor drainage. The bacteria which are responsible for nitrification are aerobic, and the chances of them being really active in water-logged conditions are very small. If conditions like these are met, it is far better to explain tactfully to the farmer that he is unlikely to get an economic return from any source of nitrogen unless the other deficiencies in the field are first remedied. Some contractors do not go to this trouble, and any work offered to them is done, irrespective of the result. For the good of the industry as a whole this indiscriminate spraying should be discouraged, or the industry will kill itself by its own mistakes.

Cereal Crops

On cereal crops gas liquor can be applied to the seed bed 72 hours before the seed is sown or can be used as a top dressing on the crop from early May until early June. Provided that the method of application is right, no permanent damage will be done to the crop, but unsuitable and heavy vehicles can bruise the crop so severely in the wheelings that when the liquor is applied the crop will be killed. If this does not happen and the crop recovers down the wheelings, ripening is usually retarded so that at harvest time the farmer is faced with a field which is ready for harvesting in some parts and not in others.

Weed Control

Applications of gas liquor can be made to kale seed beds, or the crop can be top dressed in the 4 to 6 leaf stage. Some trials have been conducted on these lines, and it is claimed that an excellent kill of weeds was obtained as well as giving the crop the benefit of the extra nitrogen. I think we can now go one better. By using tractors and spreaders designed for row crop work, we can flood the centre of the rows with gas liquor, killing the weeds and giving the crop the benefit of the nitrogen without being retarded by scorching.

Another technique on land intended for kale is that of preparing a false seed bed. The weeds are allowed to chit, and after about 10 to 14 days when liquor is applied a complete kill results. The land can be drilled within two days, and the resultant crop is free from weeds.

Sugar Beet

Convinced that gas liquor does not leach out of the soil by winter rains, we decided last year to make a bold experiment on sugar beet. For several years it has been general practice for large sugar beet growers to apply to the stubble and plough in at least 10 in., the phosphate and potash required for the sugar beet crop. It has been shown that it is thus possible to get a better shaped and less fangy beet, with a consequent ease of mechanical harvesting and lower tare weight into the factory.

Before the introduction of ammoniacal liquor, no source of nitrogen had been available which would not leach out of the soil by winter rains. With liquor this difficulty is overcome, and the need to spread extra nitrogen in the spring is done away with. Bearing in mind that soil temperature at the time of application plays an important role in retaining nitrogen, we decided to treat a limited acreage for a selected number of farmers in the Lincoln area. In all cases, only parts of fields were treated, the farmer dressing the other part of the field as he would normally have done so that comparisons could be made.

Approximately 200 acres were treated on all types of soils—heath, limestone, gravel, clay, sandy and medium loams. At the moment, no crop is comparing unfavourably with the control, but until the crop is lifted and weighed and the sugar analysis taken, we shall not know the complete story. If this experiment is as successful as it looks like being, the sugar beet crop could accommodate a large proportion of the peak winter supply of ammoniacal liquor.

Pest Control

It has been claimed from various sources that gas liquor will control the larvae of husk and liver fluke. While accepting this, we only have experience in applications of liquor for slug control. One particular experiment we did for the control of slugs was an unquestionable success. The land was heavy, wet

clay—the ideal breeding ground for slugs. The crop grown was peas, and as the season was wet they had shelled badly during harvesting. The following crop was to be winter wheat. An inspection of the field showed a large slug infestation, and we decided to treat part of it. The application of liquor was made during late evening when the slugs were on or near the surface of the soil, so that they would come into contact with the liquor. Within minutes of application the slugs could be easily seen completely de-slimed, a mass of white froth about the size of a half-crown all over the treated patch. The next morning the slugs had been shrivelled to about the size of a pea and were subsequently eaten by birds.

Winter wheat was sown, and the untreated patch suffered heavy damage from slug attack. The treated patch grew well, tillered strongly, and yielded several hundredweight of grain per acre more when combined.

Compound Fertilisers

Many people have expressed the wish for a compound fertiliser to be available in liquid form. Some people think that a compound should be made using ammoniacal liquor as a source of nitrogen, but personally, I do not think it desirable that we should attempt to make or to sell compounds. The nitrogen market is large enough to absorb all ammoniacal liquor in its existing form.

The fertiliser market is an expanding one, and we can take part in the expansion if we work together and not as a collection of individuals. We must set ourselves certain standards for the protection of our farmer customers and we must keep to them.

The gas boards can help a great deal. First, they must realise that ammoniacal liquor is not a commodity which can command a high price. If its use as a nitrogenous fertiliser is to survive the price must always be below the price of the other nitrogenous fertilisers. If the gas boards demand an unreasonable price, within ten years the use of liquor as a nitrogenous fertiliser will be looked back on as a pleasant interlude, no longer commanding any attention from the farming community.

If we can now place this small but growing industry on a sound basis, I am convinced that within the next 10 or 20 years, we shall see ammoniacal liquor used nationally as a source of nitrogen by farmers. Wages on farms will continue to rise, and farmers will look more to contractors for help, so that our development will be aided by having an efficient and organised delivery and application service available.

Need for Collaboration

In conclusion, it does appear that the time has come when the gas boards in collaboration with the various contractors handling ammoniacal liquors might well benefit by the setting up of a joint organisation to deal with the many problems arising from the application of ammoniacal liquor to the land.

A long-term programme of experimental work requires formulating so that suitable applications of liquor may be extended. Farmers should be informed of the work being done and invited to join in this research. Reports on experimental work already completed by individuals or areas require some co-ordinating body to sift out the wheat from the chaff, and all useful information should be collected in booklet form for issue to people concerned. Advertising on a national scale is an obvious and necessary function of such a committee.

The disposal of ammoniacal liquor presents a problem to many area boards. This problem can be solved if vigorous efforts are made *now* to place the disposal of this residual on a sound business footing. If gas boards would divert a fraction of the money spent in running liquor to waste to fostering its application to the land, I am certain that the investment would be worth while.

I would suggest the setting up at an early date of an agricultural department within the gas industry to further the use of ammoniacal liquor as a nitrogenous fertiliser, with experts avaliable at board headquarters to deal with technical enquiries from farmers and contractors.

DISCUSSION

The discussion was opened by the **President** (Mr. J. L. Ireland) reading the report of a Dutchman who had carried out experiments with ammoniacal liquor in the early 1930's, the point being that the application of ammoniacal liquor to the land had not progressed far in 25 years.

Mr. W. J. Spiller (Cambridge) dealt with the desirability of increasing the strength of works liquors and requested information on the problem of scorch, indicating that in his experience more scorch was apparent using vertical retort liquor than horizontal retort liquor ex Cambridge Works.

These remarks led to a lengthy discussion on the problem of scorch, and while it was felt that phenols, hydrogen sulphide, thiocyanates, temperature of application, and weather conditions generally, all had some bearing on the matter, both Mr. T. Marriott (Huddersfield) and the author considered that insufficient data had been collected to give positive proof of the degree of scorching caused by any particular item. In many cases the resultant scorching disappeared rapidly and proved no real detriment.

Mr. Bignell (Ipswich) compared the economics of liquor disposal to the land with the manufacture of concentrate, but pointed out that with so many variables in cost of steam, quantities handled, and cost of disposal as an effluent, one could not generalise, and each case required separate consideration.

Mr. K. F. Morton (West Midlands) preferred the gas boards to handle their own disposal problems rather than leaving it to contractors; he explained that in his own area spraying was carried out for ten months of the year.

Mr. D. W. Ault (Divisional Engineer, Lincolnshire) spoke in support of the author's request for discriminate use of ammoniacal liquor on farms.

Mr. Bernard Clarke (Divisional General Manager, Lincolnshire) felt that there was an outlet for ammoniacal liquors and the gas industry should foster this use. There was a growing demand for nitrogen fertilisers and the gas industry could do its part in meeting this demand. Mr. Clarke was also concerned that the application of ammoniacal liquor to the land should only be carried out under reasonable technical control.

Case for Revising Fuel Programmes

IN 'The Industrial World' feature in *The Times*, the industrial correspondent recently contributed an article calling for a reappraisal of the nuclear energy programme. His object was to draw attention to certain of the alternative courses which might be followed, and he dealt with such matters as the lower cost at which electricity might be obtained from cheaply mined coal by, say, 1965 or 1970 (in comparison with nuclear stations), the advantages of total gasification, and the ease with which gas and electricity can be transported in comparison with coal.

The article continued: 'The full comparison must take into account the cheaper—gas—alternatives of providing heat (not light or power). This implies that a larger proportion of the heat which will be used might usefully be supplied in the form of gas, and that if this were done a much smaller capital expenditure would be needed. . . . A complete change from carbonisation as a source of gas is not to be visualised because the metal industries will still require coke. But the coke will be more than ever the main product compared with gas, whose value will be determined in competition with cheaper gas-making processes. Competition from imported gas is also to be expected. Indeed, a small proportion of this may well be used in admixture with Lurgi gas to improve quality.

'If all these changes are justified economically, as appears likely, it is reasonable to ask why more has not happened on these lines before. The answer would obviously be complex. Part of it is to be found in the unsatisfactory price policies pursued, which have not reflected the capital cost of electricity fully in its price, nor discriminated coal prices fully according to costs of mining different qualities. The gas industry, now committed to total gasification and imports for future expansion, has been disunited and parochial in production. "All-electric" is an attractive slogan, and the vigorous selling of the industry before nationalisation continued without any apparent concern over co-ordination—which, after all, was a ministerial responsibility. The need for haste and the existence of scarcities have often been taken as reasons for not probing deeply into capital costs. Whatever the explanation of past policies, it cannot be a reason for avoiding serious reappraisal now.'

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WALES GAS BOARD

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CHEMIST

APPLICATIONS are invited for the post of CHEMIST at the Aberavon Works of the Port Talbot Undertaking.

Applicants should have a Science Degree or equivalent qualification, as well as practical experience in the Gas Industry or any other Fuel Industry.

The appointment will be within Grade A.P.T. 8/9 (£745/£895 per annum) and the starting salary will be dependent upon the qualifications and experience of the successful applicant.

The gases processed or manufactured at Aberavon Works are crude coke oven gas, carburetted and blue water gas, mine gas, LP-gas, blast furnace gas and producer gas. The processes include large scale purification, steam raising, water treatment, gas compression, gas dehydration and control of gas composition.

The post is pensionable. The successful applicant will be required to pass a medical examination.

Applications, stating age, and giving full particulars of education, training, qualifications and experience, together with the names of two referees, should be received by the undersigned not later than 14 days from the appearance of this advertisement.

W. F. EDWARDS,
General Manager and Secretary.

Gas Offices,
18, Station Road,
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SCOTTISH GAS BOARD

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ASSISTANT INSTRUCTOR

APPLICATIONS are invited for the above appointment in the Training Centre in Edinburgh. The duties are mainly concerned with both day and evening instruction of gas fitters and apprentices but will include instruction on installation and allied work to other types of staff. Candidates should hold at least the City and Guilds Full Technological Certificate in Gas Fitting, but preference will be given to candidates with qualifications in Gas Supply. Experience in teaching will be an added advantage. Salary A.P.T. 5 £605-£685 per annum with placing according to qualifications and experience. Additional payment will be made for evening instruction.

Applications stating age and giving particulars of education, training, qualifications and experience together with the names of two referees, should be sent to The General Manager, 15, Calton Hill, Edinburgh, 1.

EAST MIDLANDS GAS BOARD

LEICESTER AND NORTHANTS DIVISION
FOREMAN MECHANICAL FITTER, TANNER STREET WORKS, NORTHAMPTON UNDERTAKING

APPLICATIONS are invited from qualified FITTERS for the post of Foreman Mechanical Fitter at Tanner Street Gasworks, Northampton. The applicant will be responsible to the Works Engineer or his deputy for the control and direction of several types of tradesmen and unskilled personnel engaged in the maintenance and repair of the plant. The Works comprises installations of continuous vertical retorts, catalytic oil gas plants, coal and coke handling plant, boosting and compressing plant and similar equipment associated with a modern Gasworks installation.

Applicants must have a sound background of workshop practice and experience, and preferably be conversant with the type of equipment referred to above.

The salary for this appointment will be within Grade A.P.T. 5 (£605/£685 per annum) of the National Salary Scales recently agreed by the National Joint Council for Gas Staffs, and all other conditions of service as laid down by the National Joint Council for Gas Staffs, the hours of work being 44 per week. The post is pensionable, and the successful applicant will be required to pass a medical examination.

A house, subject to Service Occupation Agreement, is available if required.

Applications giving full details of qualifications, training and experience, together with present post and salary and the names and addresses of two referees, should reach the Group Manager, East Midlands Gas Board, 45, Abington Street, Northampton, by not later than November 30, 1957.

H. B. TAYLOR,
Divisional General Manager.

Millstone Lane,
Leicester.

November 5, 1957.

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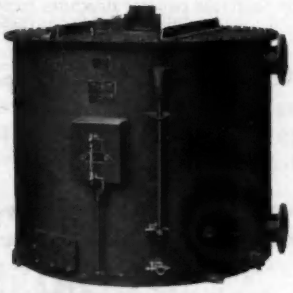

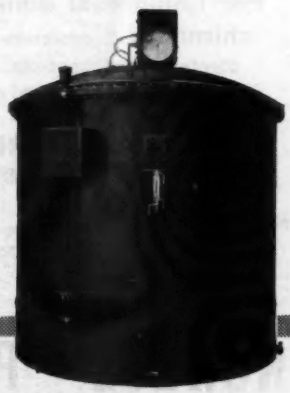

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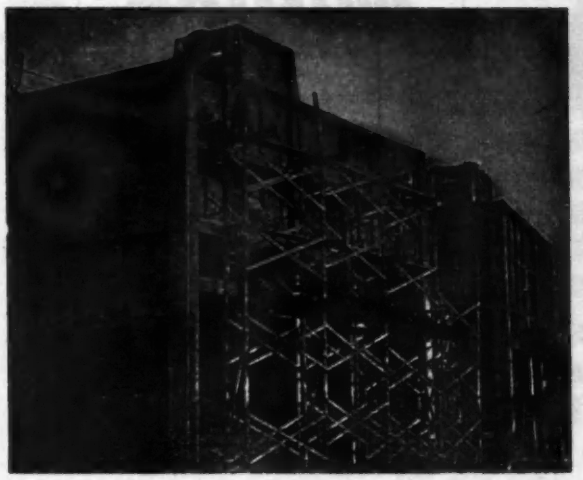

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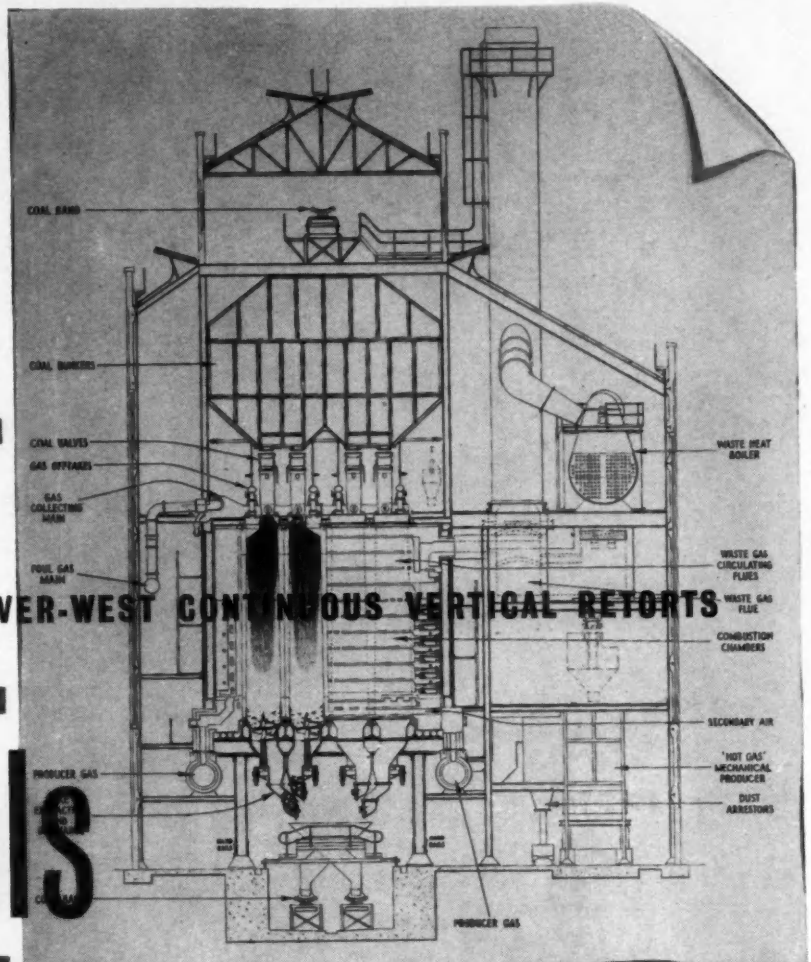
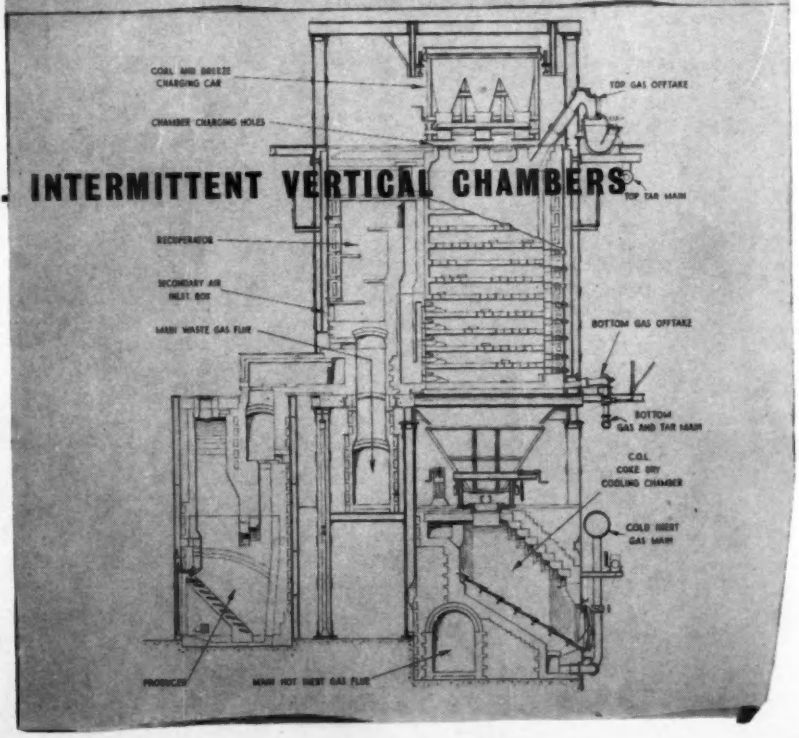
West's for Verticals



GLOVER-WEST CONTINUOUS VERTICAL RETORTS



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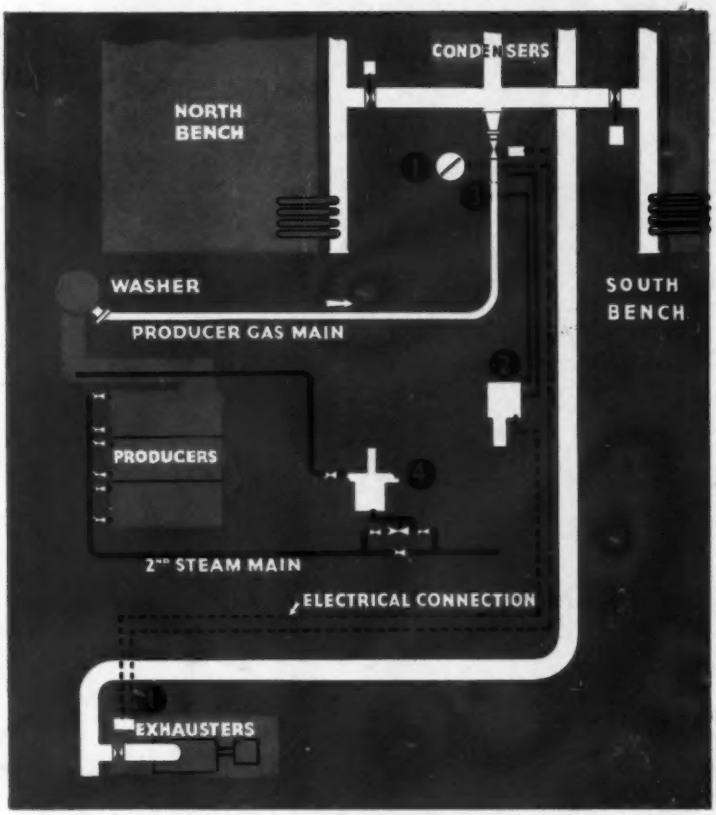
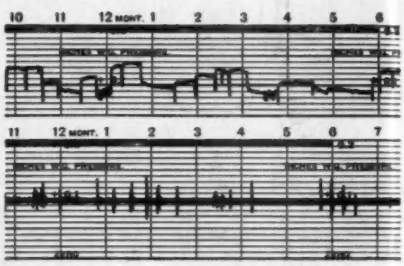
AN AUTOMATIC CONTROL INSTALLATION FOR INCREASED EFFICIENCY IN GAS MAKING



At the Ponders End Works, Tottenham Division, Eastern Gas Board, raw gas from two I.V.C. benches is diluted by approximately 50 B.Th.U., by washed producer gas. The diluent gas is introduced before the primary condensers via a motorised proportioning valve. The valve is operated remotely by push button controls about 400 feet away. Here the C.V. trend is observed on a nearby calorimeter connected at inlet to benzole plant.

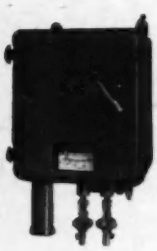
An Electroflo ring balance, transmitting flow meter is installed near the producer gas valve. Diluent flow rate indicators are situated in the exhauster house, and at the valve itself which can be manually operated in the case of electrical failure.

Venturi steam to the diluent producers is automatically controlled by a series 55 oil-operated regulator to maintain constant offtake pressure conditions.



Diluent producers offtake pressure records. The lower chart shows the effect of automatic control of Venturi steam.

1. 12" DIA. INDICATORS show flow rate of diluent under remote control.



2. RING BALANCE GAS FLOW TRANSMITTER and orifice plate, **3**, in diluent main operating flow indicators as above.

4. SERIES 55 OFFTAKE REGULATOR automatically controlling Venturi steam to diluent producers.

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